SCIENCE

8 December 1961
Vol. 134, No. 3493

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

Preconvention Issue

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...to isolate smaller molecules

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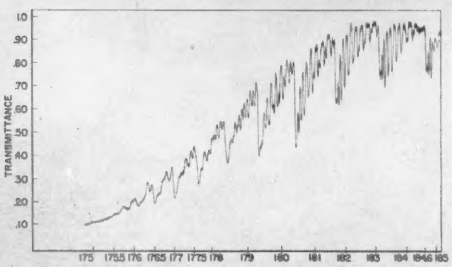
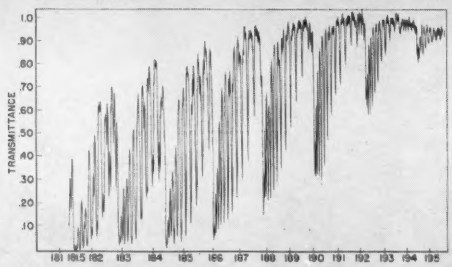
Far Ultraviolet Spectrum of Oxygen.



Air and nitrogen, 2 cm. cell, 14-minute scan.



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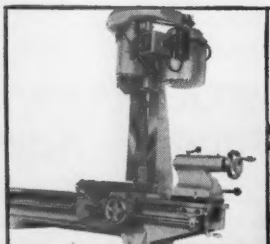

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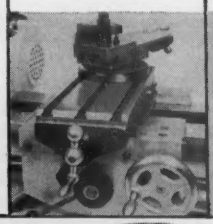

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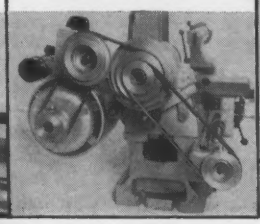

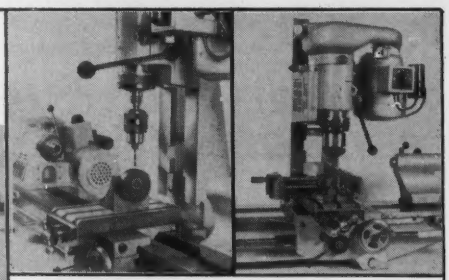

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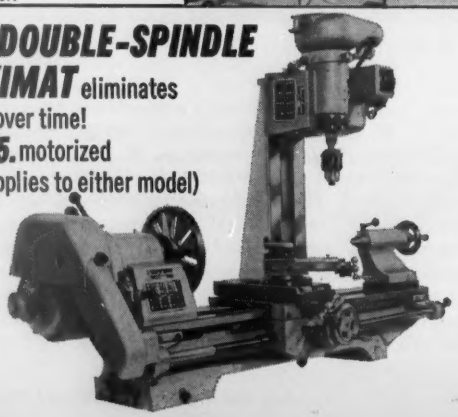

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Spindle nose to cross slide table	12¼"
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Table, longitudinal feed	19⅜"
6-bearing Headstock Spindle	
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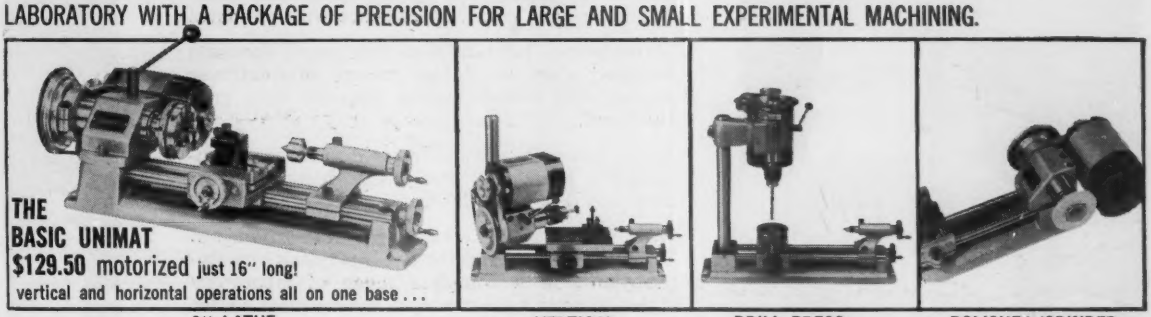

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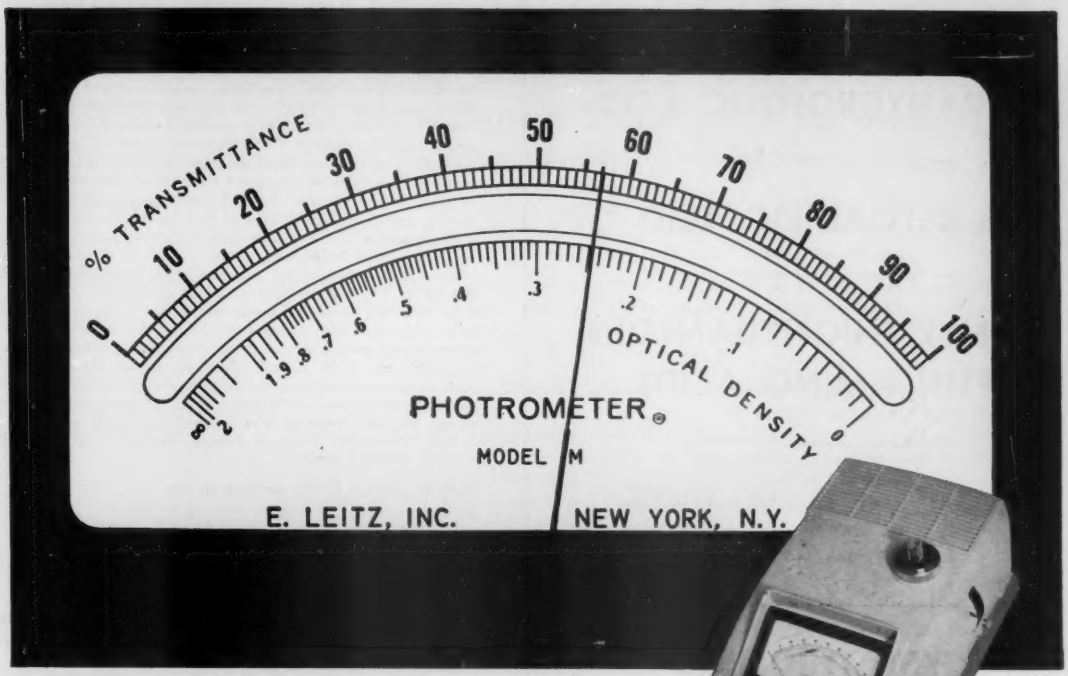

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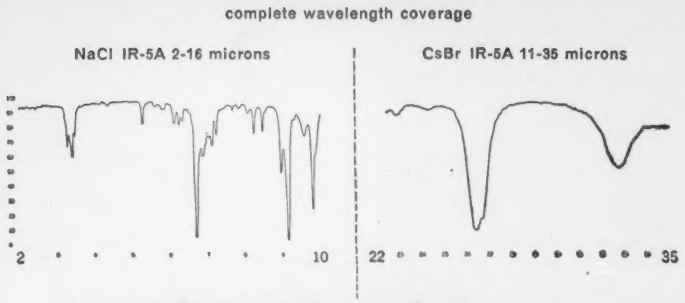

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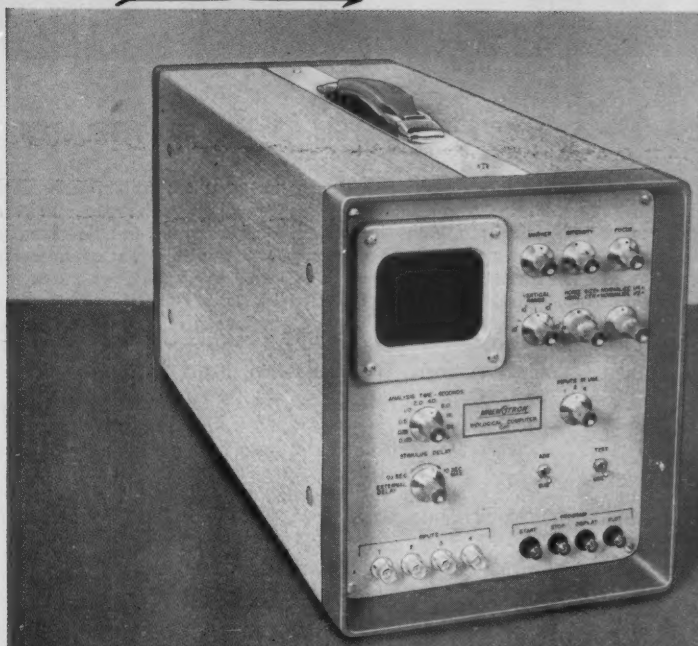

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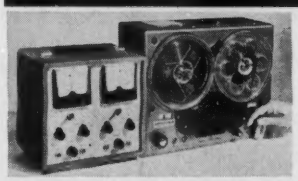

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$19.35 Try the "cage that stands by itself."

The New Disposable Econo-Cage #21, Pictured Above, Brings To Animal Care A Rigid Plastic Disposable Cage That Spells Real Economy. It Stands By Itself Requiring No Expensive Supports That Prevent Full Visibility. Designed Primarly For Mice, The Cage is 11½" x 7½" x 5" Deep. The Floor Area Of 84 Square Inches Will Adequately House Up To 12 Mice. All 20 Series Lids Fit The New Disposable Econo-Cage #21.

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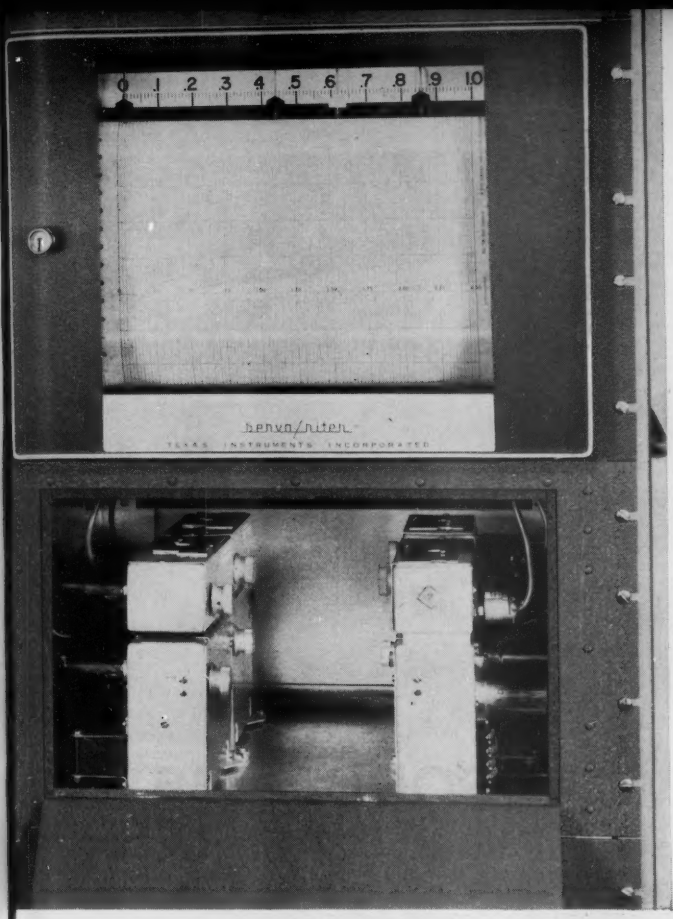
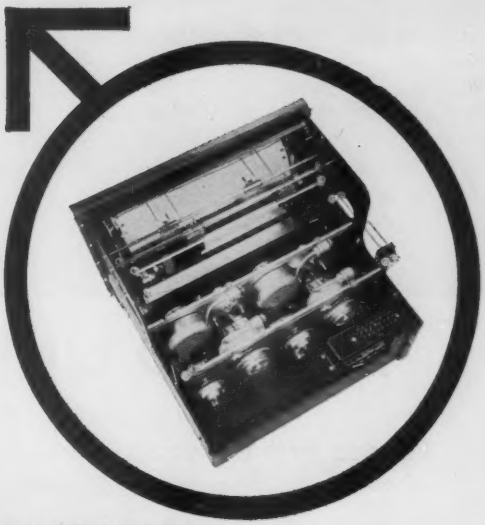


NEW from TI

4-CHANNEL servo/riter* RECORDER



RECORDS 4 CONTINUOUS CHANNELS ON A WIDE SINGLE CHART

You can now record four continuous channels of data on a wide single chart . . . four overlapping pens continuously recording on the full width of the 9¾" chart. For the first time in a potentiometric recorder four variables can be traced with high resolution on a single sheet of chart paper! The recorder is the proved *servo/riter* in the flush-mounting configuration for use in standard 19" relay racks.

Amplifiers are separate from the recorder and may be mounted as far as 15 feet from the recorder chassis. An optional factory-assembled package places the four amplifiers in a standard rack-mounting case for location adjacent to the recorder case.

In addition, five- and six-channel *servo/riter* recorders are available, utilizing overlapping pens on dual side-by-side 4½" charts. Two- and three-channel recorders are offered in both the narrow and wide configurations, with all pens writing on only *one* sheet of chart paper.

The same industry-proved performance characteristics and wide ranges of the single and dual-channel *servo/riter* recorders are designed into the new multi-channel instruments. These include:

- HIGH SENSITIVITY—
  1.0 mv to 100 mv full-scale
- HIGH INPUT IMPEDANCE—
  4 megohms off-balance
- FAST RESPONSE—
  .5 second full-scale rise time
- HIGH REJECTION RATIOS—

"Transverse"	1,000/1
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FAST RESPONSE—less than one second required for full scale pen travel, for faithful transcription of peaks and valleys in the curve.

ACCURACY—¼% or 20 microvolts, which, coupled with the wide chart, provides more than sufficient reading accuracy—especially important when considering alternative applications.

REPRODUCIBILITY—to a fraction of a millimeter, ensuring that the accuracy of analytical measurement is not limited by the measuring instrument.

SPECIAL CHART—wide 240 mm scale (0 to 100) for best reading accuracy. Zero point is at left for logical presentation of wavelength axis.

VARIABLE LINEAR RANGE—permits full scale presentation of any %T range from 0-10 to 0-100.

LOG RANGE SELECTION—permits full scale presentation of either 0-1 or 1-2 absorbance ranges.

SYNCHRONOUS SWITCHING—for convenient, simultaneous engagement of scan and chart drive from one switch position. (Scanning with DU requires SERA attachment.)

TRUE POTENTIOMETRIC RECORDING—variable range accomplished by adjustment of potentiometric bridge network—independent of input circuit resistance.

VERSATILITY—useable for all other laboratory recording applications through use of standard accessories.

S-72180-5 RECORDER—POTENTIOMETRIC, LINEAR-LOG RECORDING, SARGENT MODEL SRL (PAT. NO. 2,931,964). With integral panel control to adjust range from 0-10 to 0-100 millivolts and with alternate logarithmic recording of 0-1 or 1-2 orders by interchange of precision generated linear and log gears in the pen drive system, for highest accuracy. Ranges from 0-10 to 0-100%T and 0-1 or 1-2 absorbance are provided. Complete with 1 roll S-72167 chart paper and with cables for connection to spectrophotometer. $950.00

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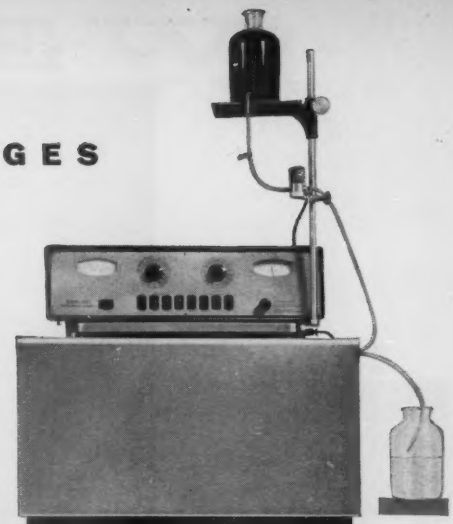
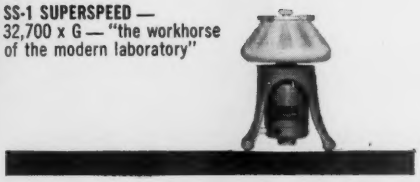


RC-2 AUTOMATIC SUPERSPEED REFRIGERATED — up to 37,000 x G with SS-34 Rotor. Accepts five other rotors. Shown set up for KSB Continuous Flow operation. KSB system may also be used with SS-1, SS-3 and SS-4

SS-1 SUPERSPEED — 32,700 x G — "the workhorse of the modern laboratory"



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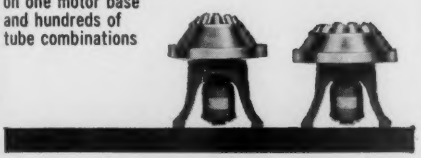

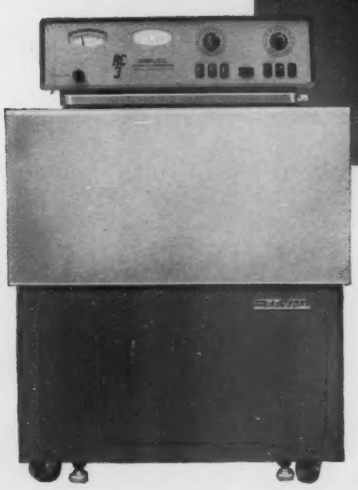

RC-3 GENERAL PURPOSE AUTOMATIC REFRIGERATED — 5,000 rpm, — 5,100 x G. 70 seconds to operating speed; seconds to stop. Reduces thirty-minute jobs to five minutes. Ideal for general, routine, and blood work

SS-3 AUTOMATIC SUPERSPEED — 17,000 rpm, 34,800 x G — brings true automation to the busy laboratory

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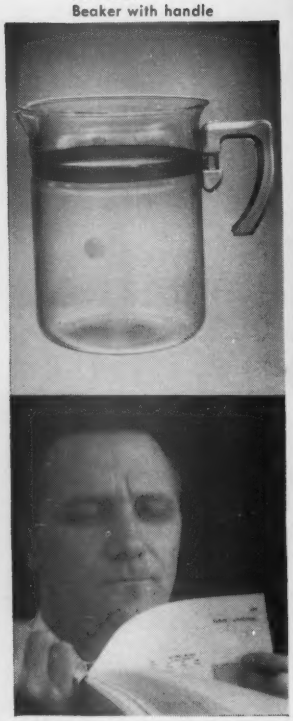
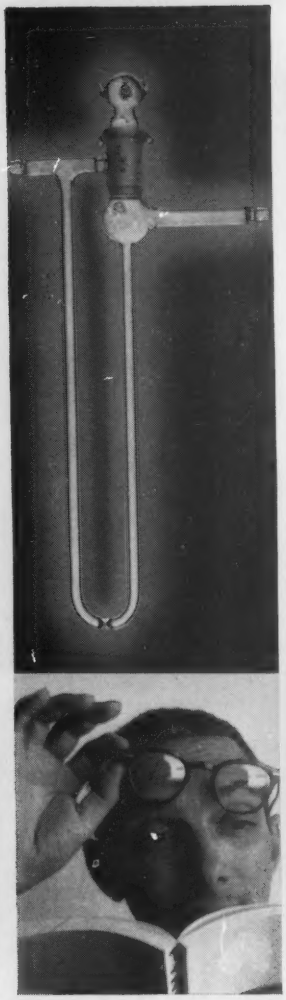
No. 1010
Beaker with handle



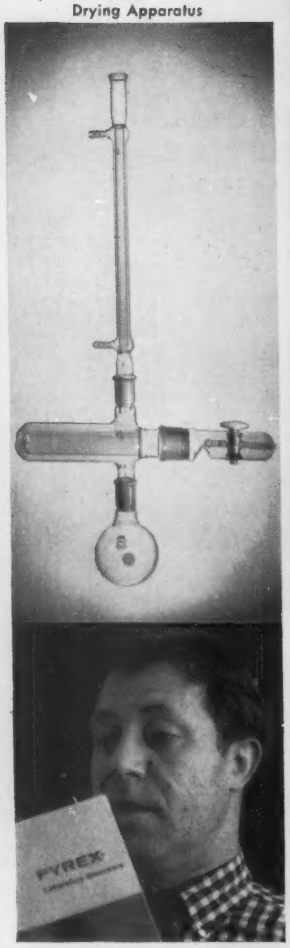
Hmm, a beaker with a handle. Makes sense. Should lift and pour as easy as a coffeepot — even when it's boiling hot. Won't need those clumsy tongs now.*

No. 5960
Flowmeter



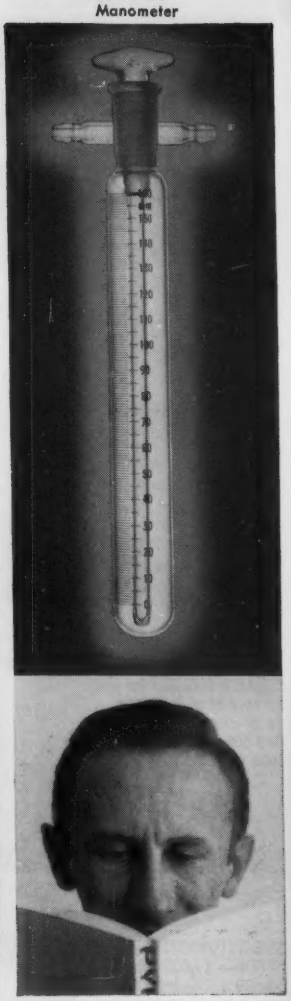
Four orifices on this flowmeter. From ¼ to 2 mm. Says you just turn the stopper to select the one you want. That's pretty simple.*

No. 3690
Drying Apparatus



Drying apparatus for small quantities. Works at constant temperature, under reduced pressure. I won't have to buy separate parts and make my own after all.*

No. 6952
Manometer



A "t" manometer. Scaled from 0 to 160 mm. The scale is red for easy reading. Available in single outlet also. Real easy to fill.*

* MORAL?

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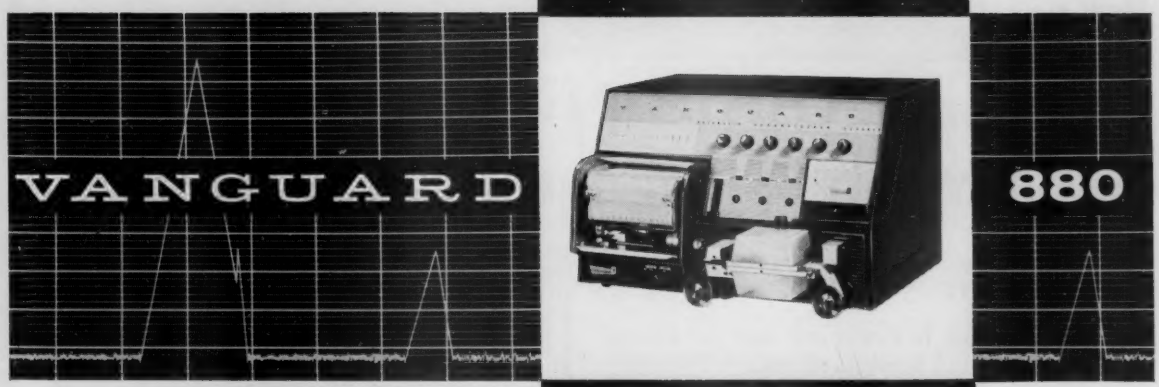
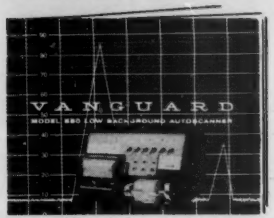
Vanguard 4 pi AUTOSCANNER reduces background to less than 10 c pm., revolutionizes counting of H^3, C^{14}, and S^{35}

Vanguard's new, completely transistorized Model 880 Low Background AUTOSCANNER revolutionizes chromatogram scanning of low-energy, beta-emitting radioisotopes. Specially designed to meet the exacting requirements of medical, agricultural and pharmaceutical research, the AUTOSCANNER utilizes the most advanced electronic and mechanical design, integrated into a compact, one-piece console. With the Model 880, analyses can be performed with the highest possible degree of sensitivity—even when counting tritium, carbon-14 and sulphur-35.

NEW STANDARD ACCESSORY, TOO! Also available is the new, exclusive Vanguard Model 880ADS, a completely automatic system for quantitative integration and digital presentation of radioactive zones. For complete details concerning either the Model 880 or Model 880ADS, please write or call.



REQUEST THIS BROCHURE— See how you can achieve the highest detection efficiency available for chromatogram scanning. Booklet outlines distinctive features and lists all operational characteristics of the Model 880 AUTOSCANNER.



- Features 4 pi scanning—counts radiation on both sides of strip simultaneously
- Reduces background to less than 10 cpm.
- Completely transistorized for longer, more reliable performance
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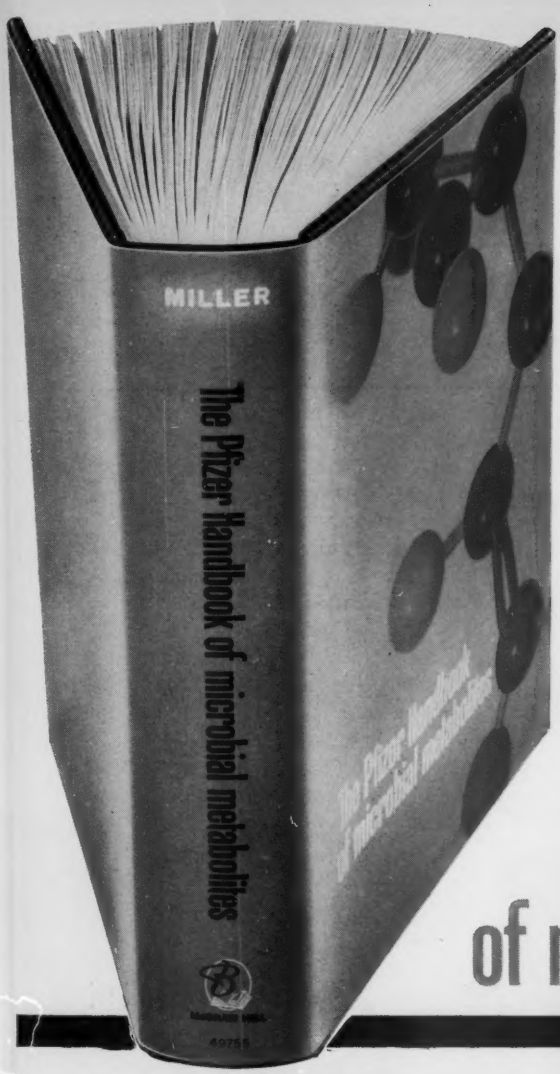

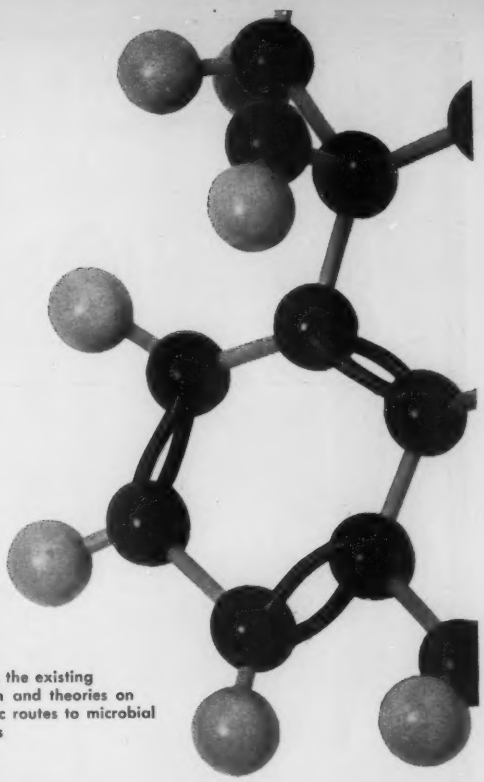

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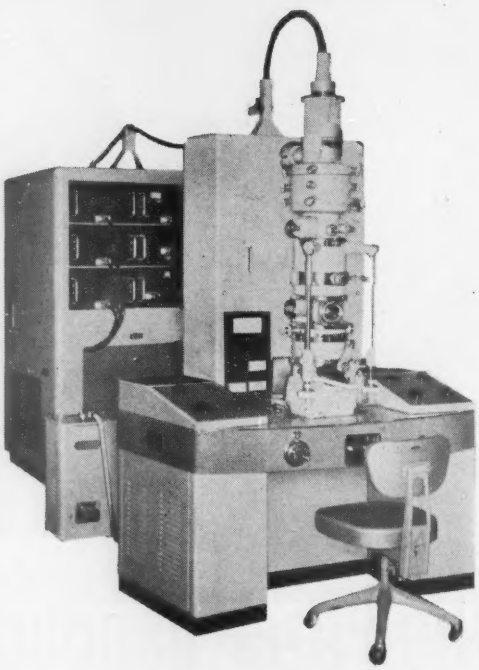

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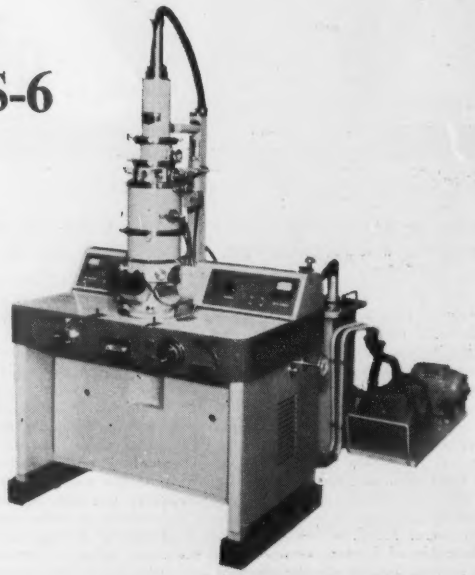

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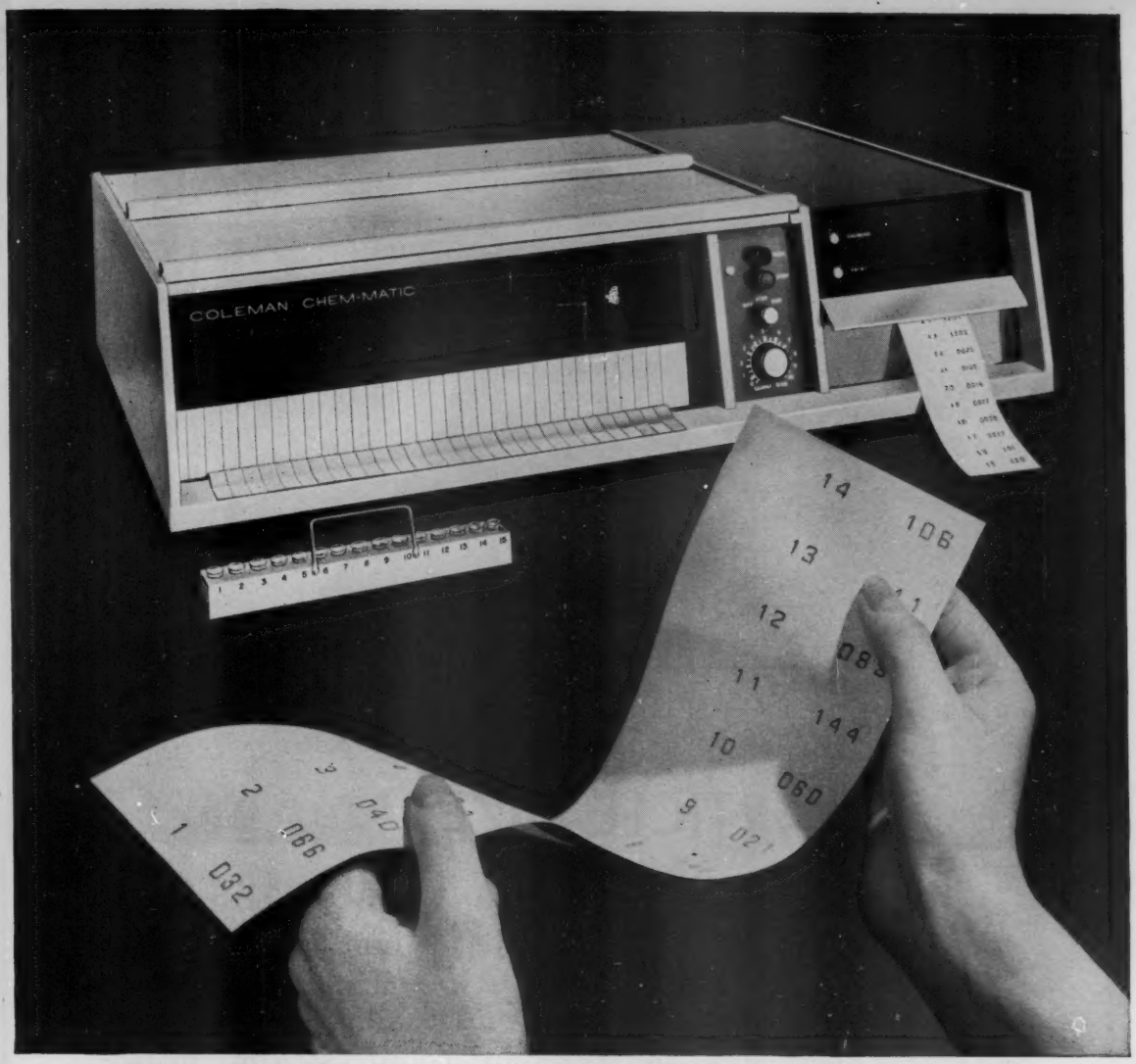

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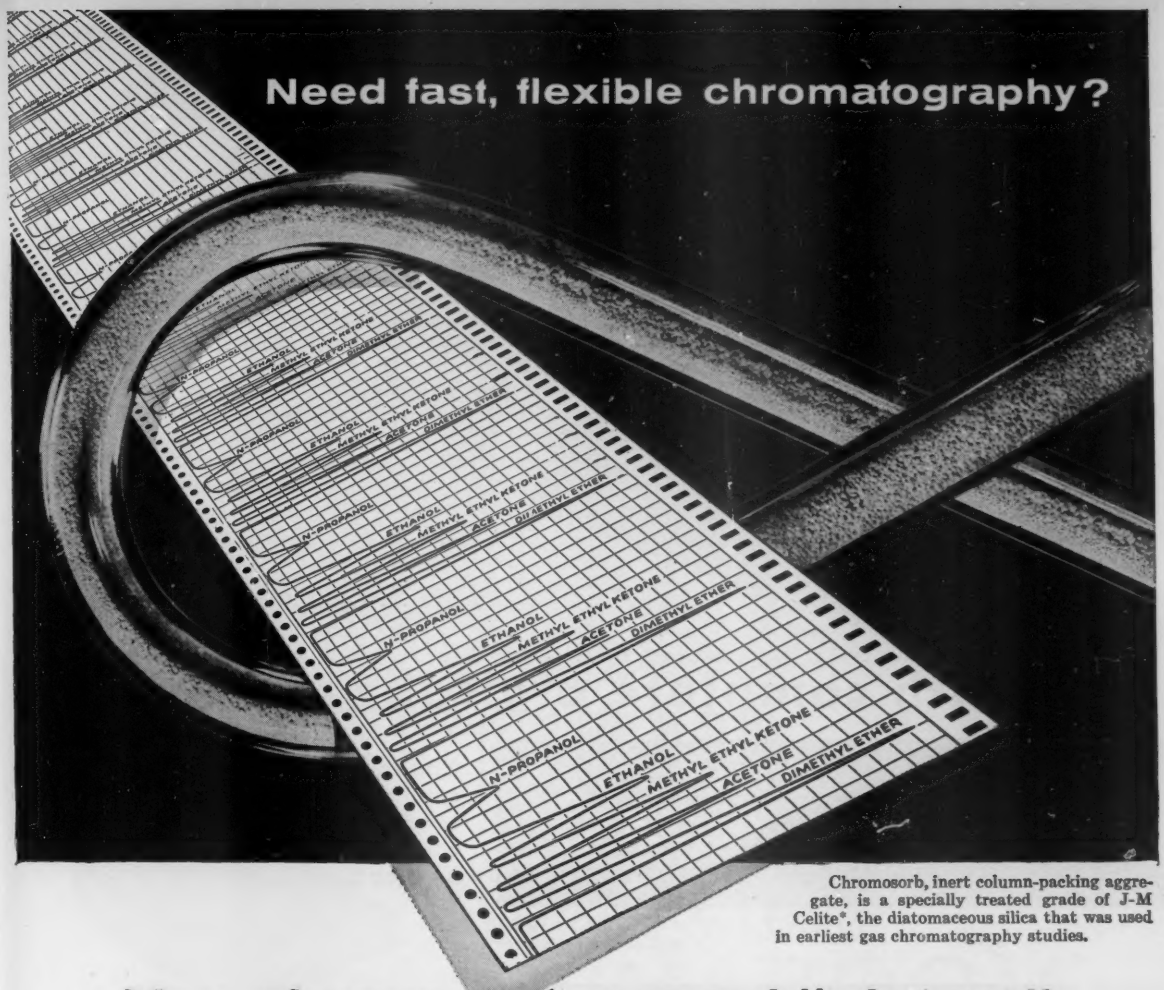

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Water Absorption—cc./gr. (avg.)	2.4
Moisture—% by weight, maximum	1.0
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Surface Area—sq. m./gm. (avg.)	3-5

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Moisture—% by weight, maximum	1.0
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Surface Area (BET Method)—sq. m./gr. (avg.)	3-4

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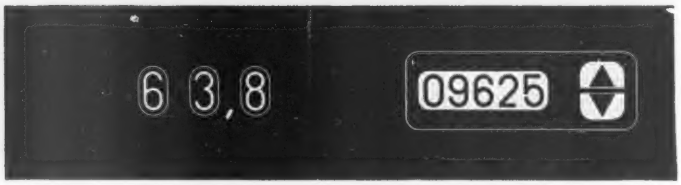
. . . with complete digital read-out . . .

actual size read-out

The macro-analytical balance, type S-5, capacity 160 grams, reads to 5 decimal places – the 5th place showing either as 0 or 5.



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The new Mettler balance, type S, incorporates patented features which have proven themselves in other Mettler models. In addition, it has a complete digital read-out, also patented by Mettler. This is not just a matter of great convenience to the operator, but a completely successful means to eliminate a significant subjective error, which occurs when the final digits of a result are estimated.

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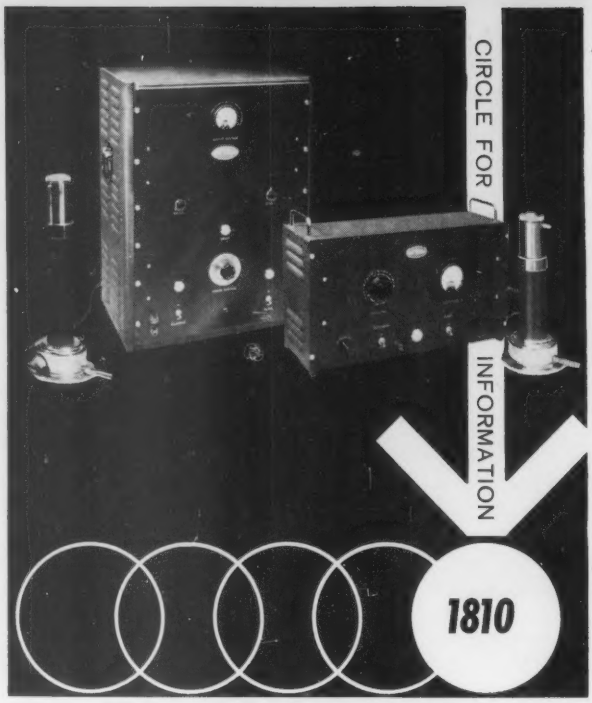

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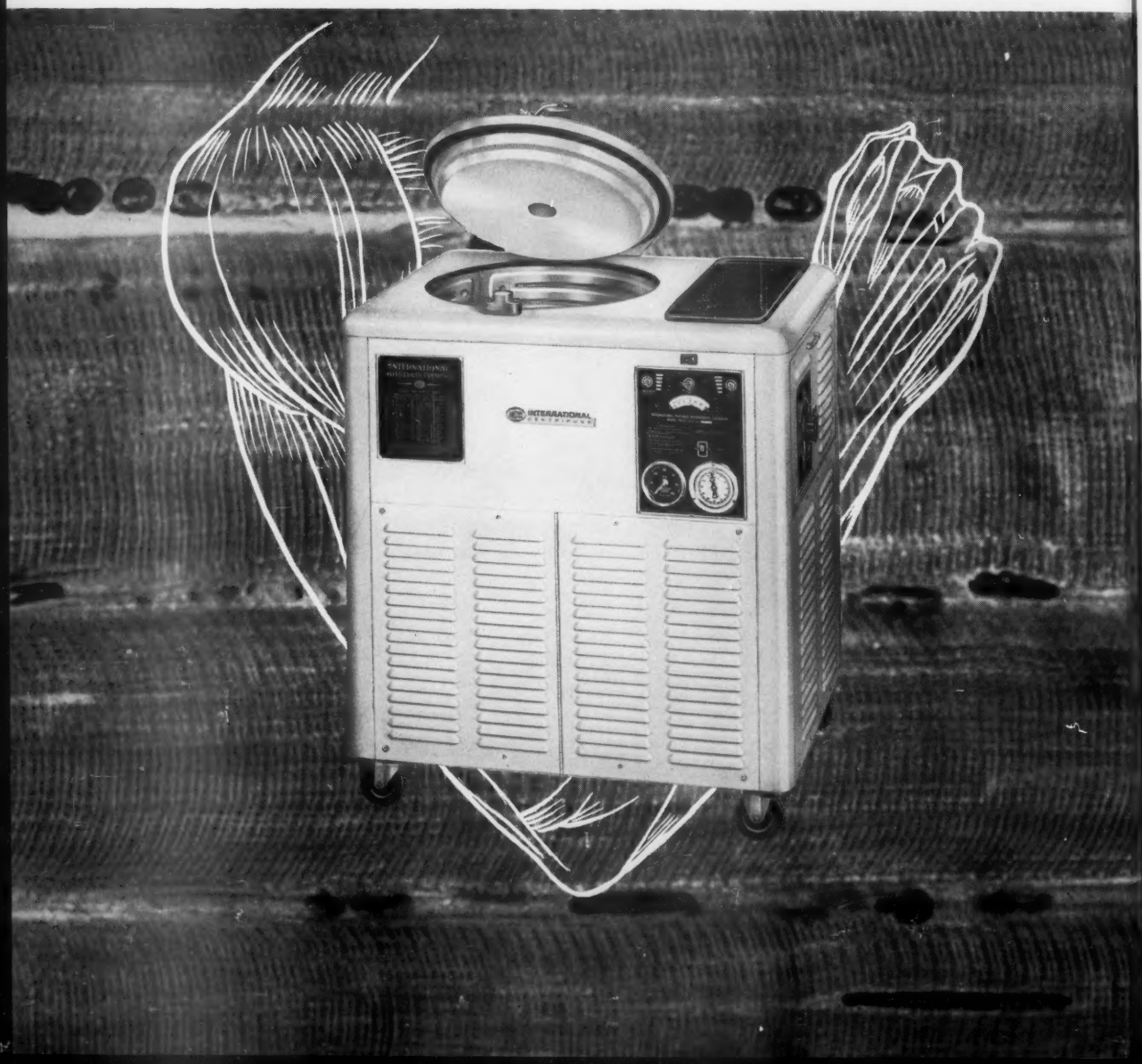

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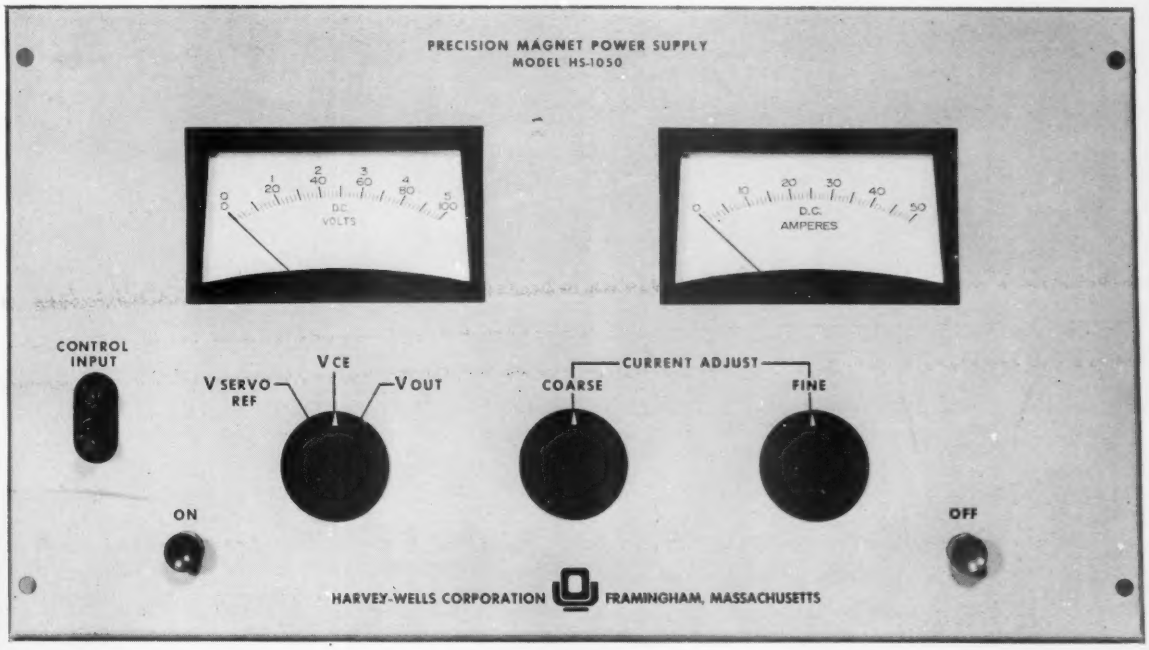

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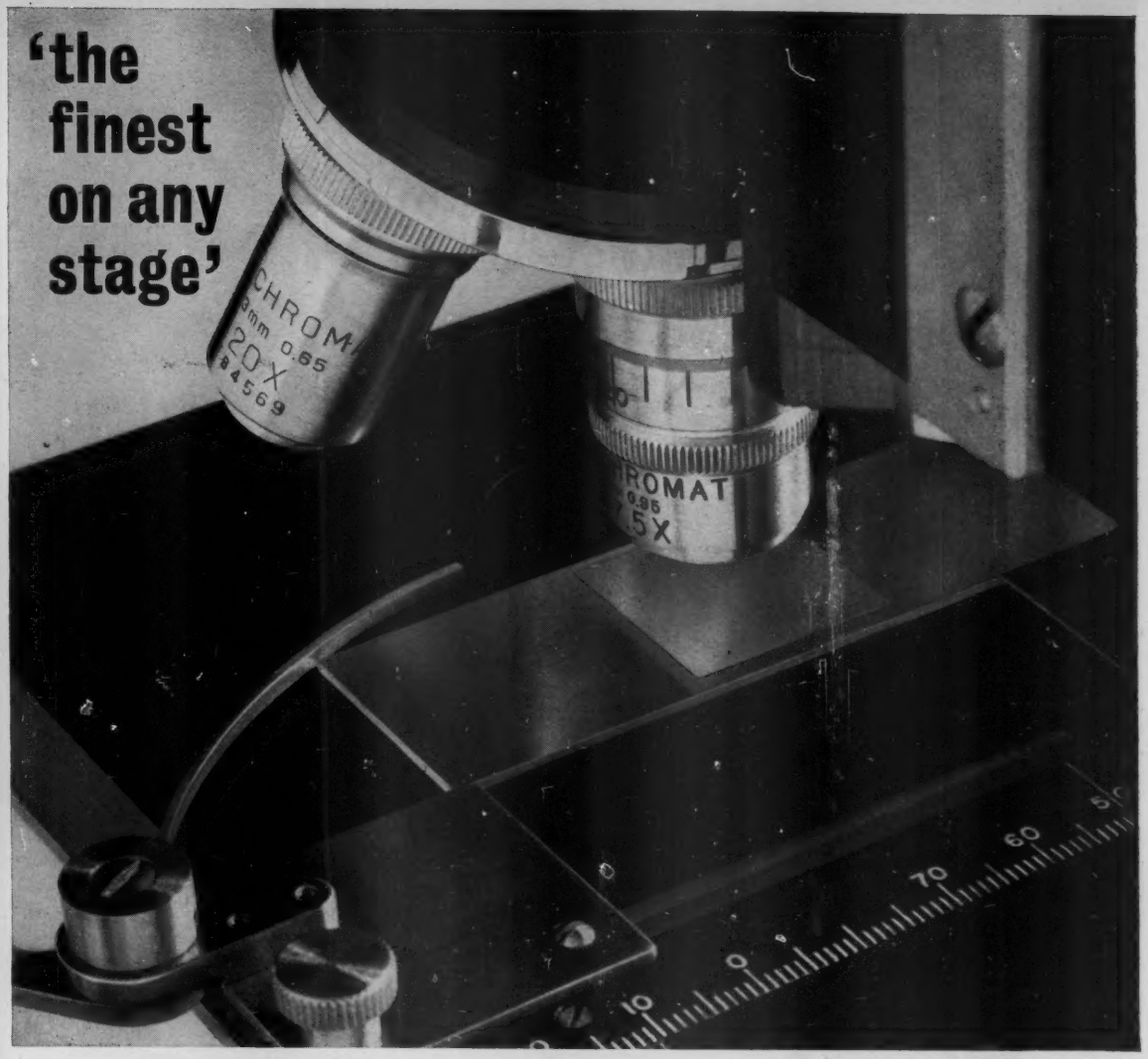

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Your dealer carries "Gold Seal" microslides and cover glasses and a large selection of microslide boxes, cabinets, and other accessories. Illustrations and full details of all items may be found in the Clay-Adams catalog No. 106. If you do not have a copy, write today on your institutional letterhead to:

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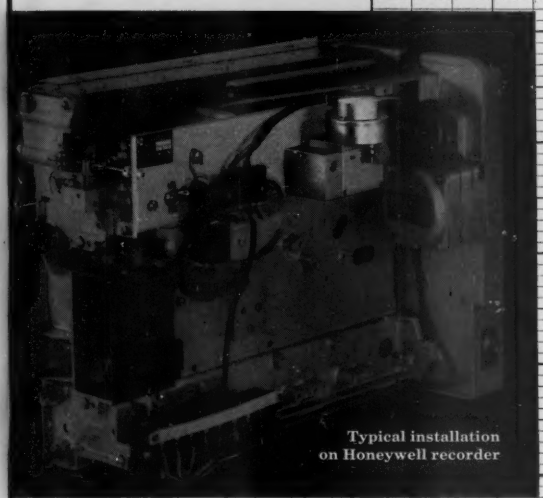
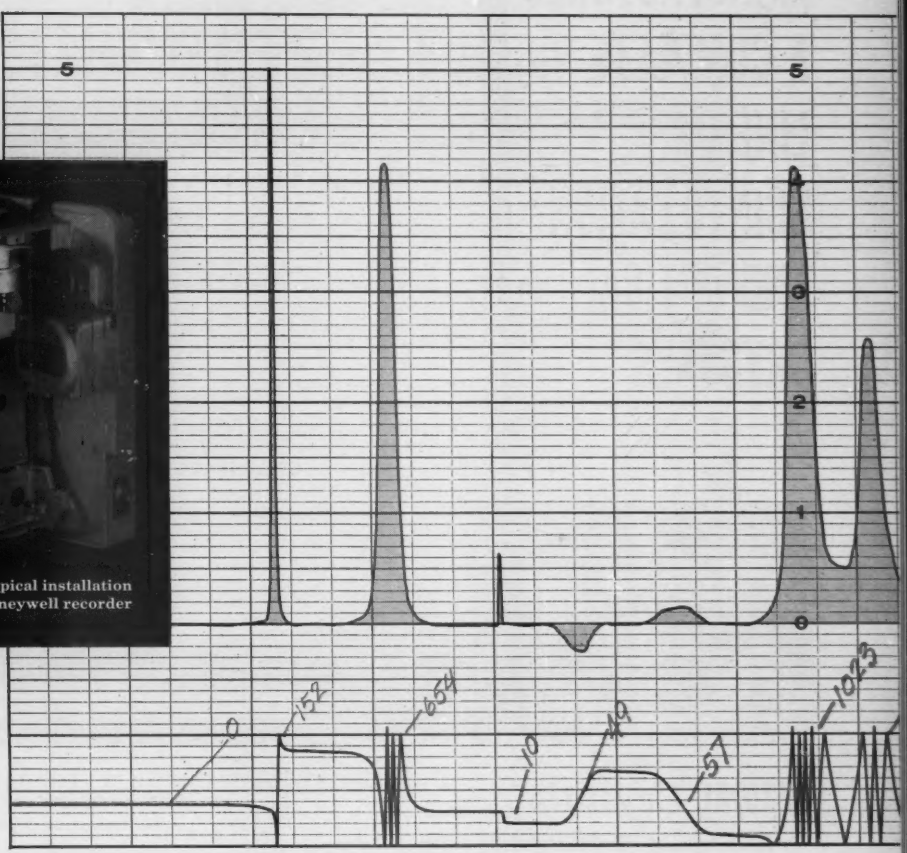
New Disc Integrator Delivers Precise, Quantitative, Chromatogram Analysis For Less Than $600



Typical installation on Honeywell recorder



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Count rates from 100 per hr. to 30,000 per min.

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Continuous output for chart, remote counter, or printer

*No zero drift**

**In some older models zero drift did occur. This can now be corrected. Write for details.*

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Now, peak area measurements of chromatograms can be accurately determined without costly instrumentation or laborious calculation. Mounted within any standard strip chart recorder, the new Disc Series 200, Chart Integrator, automatically computes peak areas and records a trace which can be interpreted in area units for any chart interval. To facilitate chart interpretation, a blip readout occurs every sixth traverse of the integrator pen, enabling easy definition of up to 24,000 counts per chart inch. Optional electrical read-out is available for actuating remote counters or printers.

Disc Integrators may be obtained with new recorders or can be easily installed by laboratory personnel in 2 to 3 hours on any of these recorders: *Honeywell Type 143 and 153, Honeywell Electronik 17, Bristol Dynamaster, Westronics S11A, Leeds and Northrup Speedomax G and H, Sargent Models SR and MR, Wheelco Series 8000, Weston Model 6701, Texas Instruments WS Models.*

Series 200 Disc Integrators are available from manufacturers of chromatographic or recording instrumentation, laboratory apparatus dealers, or from the manufacturer. Write for Bulletin S-200 for complete information.

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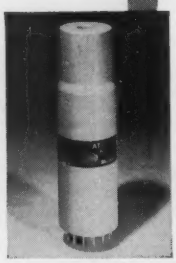

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For Infrared and Ultra Violet Transmitting Optics

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GET YOUR ADVANCE COPY

of the General Program of the AAAS Denver Meeting

by first class mail – early in December

The *General Program* of the 128th Meeting of the AAAS in Denver, 26–31 December 1961, will be available to you, at cost, within the first week in December—whether you can attend the Meeting or not.

Program Content

1. The two-session AAAS General Sessions, "Moving Frontiers of Science," Part I—Speakers: Howard A. Meyerhoff and Arthur R. von Hippel; Harrison Brown, presiding. Part II—Speakers: Halton C. Arp and E. W. Fager; Harrison Brown, presiding.
2. The 29th John Wesley Powell Memorial Lecture. Speaker: Glenn T. Seaborg; Paul M. Gross, presiding.
3. On "AAAS Day," the four broad, interdisciplinary symposia—Physics of the Upper Atmosphere; Geochemical Evolution—The First Five Billion Years; Existing Levels of Radioactivity in Man and His Environment; and Water and Climate—arranged by AAAS Sections jointly.
4. The Special Sessions: AAAS Presidential Address and Reception; Joint Address of Sigma Xi and Phi Beta Kappa by Harrison Brown; the Tau Beta Phi Address by John A. Logan; National Geographic Society Illustrated Lecture; and the second George Sarton Memorial Lecture by Joseph Kaplan.
5. The programs of all 18 AAAS Sections (specialized symposia and contributed papers).
6. The programs of the national meetings of the American Astronomical Society, American Society of Criminology, American Nature Study Society, American Society of Naturalists, American Society of Zoologists, Beta Beta Beta Biological Society, Biometric Society (WNAR), National Association of Biology Teachers, Scientific Research Society of America, Society for General Systems Research, Society of Protozoologists, Society of Systematic Zoology, and the Society of the Sigma Xi.
7. The multi-sessioned special programs of the American Astronautical Society (Hugh L. Dryden as dinner speaker), American Physiological Society, American Psychiatric Association, Association of American Geographers, Ecological Society of America, National Science Teachers Association, National Speleological Society—and still others, a total of some 70 to 80 participating organizations.
8. The sessions of the Academy Conference, the Conference on Scientific Communication, and the Conference on Scientific Manpower.
9. The sessions of the AAAS Cooperative Committee on the Teaching of Science and Mathematics, of the AAAS Committee on Science in the Promotion of Human Welfare.
10. Titles of the latest foreign and domestic scientific films to be shown in the AAAS Science Theatre.
11. Exhibitors in the 1961 Annual Exposition of Science and Industry and descriptions of their exhibits.

Advance Registration

Advance registration has these decided advantages: (1) You avoid delay at the Registration Center upon arrival; (2) You receive the *General Program* in ample time to decide, unhurriedly, which events and sessions you particularly wish to attend; (3) Your name is posted in the Visible Directory as the Meeting opens.

The following coupon may be used both by advance registrants and by those who wish only the advance copy of the *General Program*.

——————THIS IS YOUR COUPON FOR AN ADVANCE COPY OF THE GENERAL PROGRAM——————

1a. ☐ Enclosed is $3.50 for my advance Registration Fee which brings me the *General Program*, Convention Badge, and all privileges of the Meeting (50¢ is for first-class postage and handling).

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APPLICATION FOR HOTEL RESERVATIONS
128th AAAS MEETING
Denver, 26–31 December 1961

The hotels for the AAAS Denver meeting have established special, low rates and have reserved appropriately large blocks of rooms for this meeting. Thus everyone making room reservations for the AAAS meeting is assured substantial savings.

The list of hotels and the reservation coupons below are for your convenience in making your hotel reservation in Denver. Please send your application, *not* to any hotel directly, but to the AAAS Housing Bureau in Denver and thereby avoid delay and confusion. The experienced Housing Bureau will make assignments promptly; a confirmation will be sent you in two weeks or less.

If requested, the hotels will add a comfortable roll away bed to any room, at $3.00 per night. Mail your application now to secure your first choice of desired accommodations. All requests for reservations must give a definite date and estimated hour of arrival, and also probable date of departure.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

For a list of the headquarters of each participating society and section, see page 197, *Science*, 21 July. The Hilton is the AAAS headquarters hotel.

Rates for Rooms with Bath*

Hotel	Single for one	Double for one	Double for two	Twin Beds for one	Twin Beds for two	Studio Twins	Suites
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Brown Palace	8.00	9.00	13.00	$10.00	15.00		24.00 to 65.00
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Shirley Savoy		7.50	10.00	9.00	12.00		25.00 to 40.00

* All rooms are subject to a 2% Colorado State sales tax.

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AAAS Housing Bureau
225 West Colfax Avenue
Denver 2, Colorado

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Please reserve the following accommodations for the 128th Meeting of the AAAS in Denver, 26–31 December 1961:

TYPE OF ACCOMMODATION DESIRED

Single Room ..... Double-Bedded Room ..... Twin-Bedded Room ..... Studio Twins .....

Suite ..... Desired Rate ..... Maximum Rate .....

Number in party ..... Sharing this room will be: .....

(Attach list if this space is insufficient. The name and address of each person, including yourself, must be listed.)

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First Choice Hotel ..... **Second Choice Hotel** ..... **Third Choice Hotel** .....

DATE OF ARRIVAL ..... DEPARTURE DATE .....
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NAME .....
(Individual requesting reservation) (Please print or type)

ADDRESS .....
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Mail this now to the Housing Bureau. **Rooms will be assigned and confirmed in order of receipt of reservation.**

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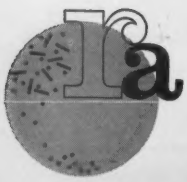

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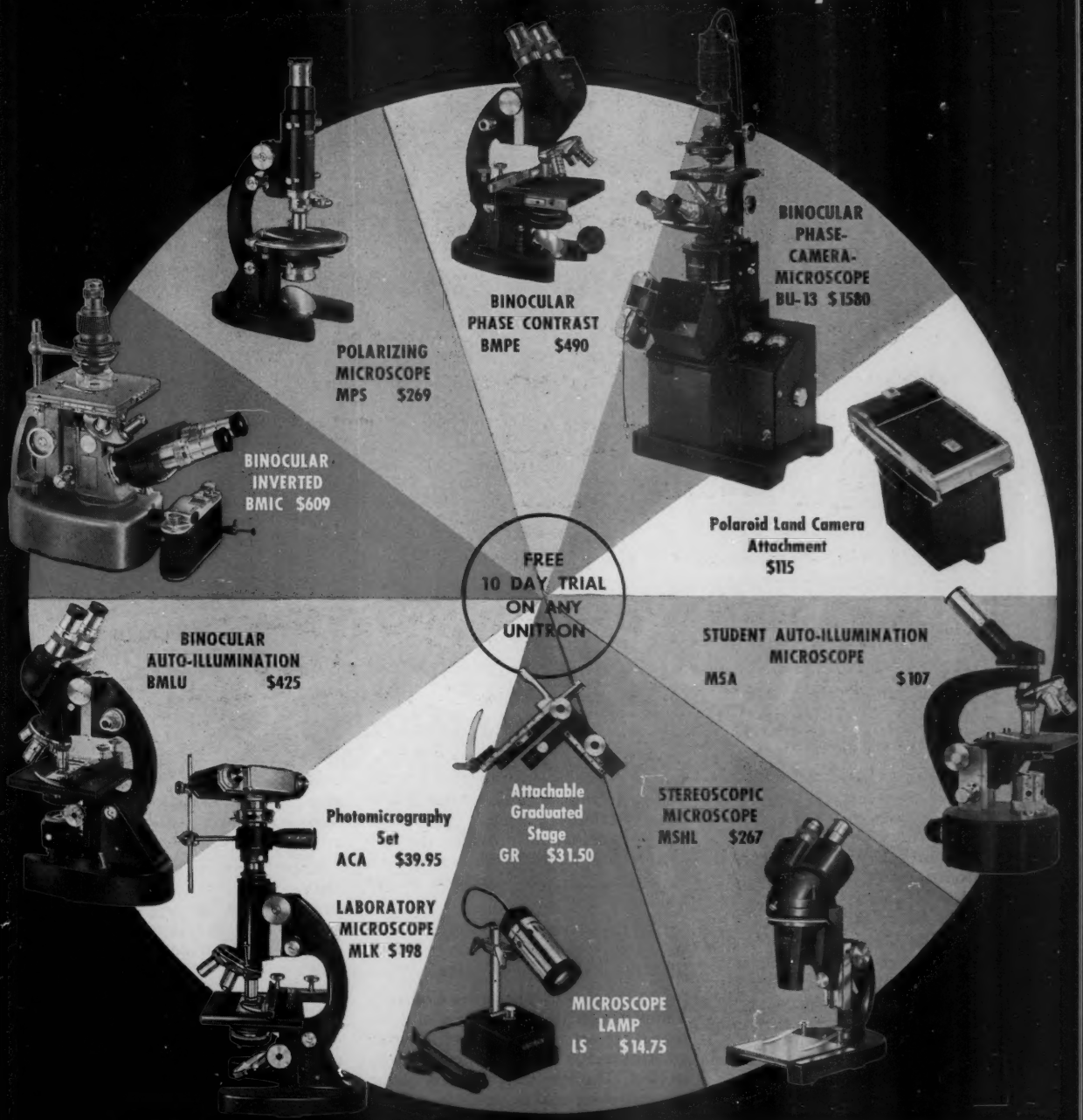

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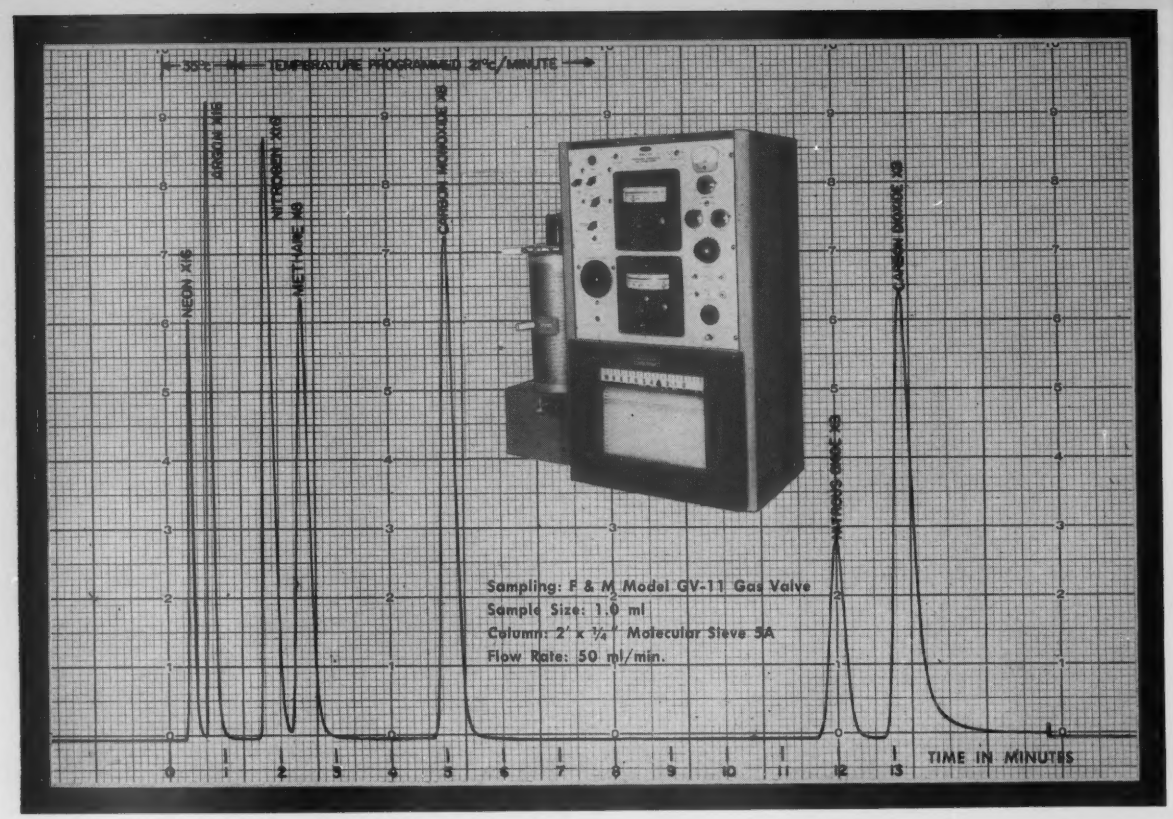

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An example of this is shown in the above chromatogram. In less than 15 minutes, a complete separation was obtained for a mixture of neon, argon, nitrogen, methane, carbon monoxide, nitrous oxide, and carbon dioxide. Other gases for which molecular sieve columns are applicable include: ethane, ethylene, propane, hydrogen, deuterium, oxygen, nitric oxide, krypton, and xenon.

The above analysis was performed on an F & M Model 500 programmed temperature gas chromatograph, equipped with an F & M Model GV-11 gas sampling valve. This instrument combination provides the following advantages which are essential to reliable, accurate analyses of gas mixtures:

(1) *Repeatable Sampling.* Sample sizes are repeatable to within ± 0.25% with the Model GV-11 valve.

(2) *Precise Temperature Controls.* Temperatures of the column and detector are separately controlled from ambient to 500°C by proportional controllers. The low thermal mass of the column oven makes possible a close adherence to a wide range of temperature programs.

(3) *Precise Flow Control.* The differential pressure flow control system used on the Model 500 assures a constant mass flow rate of carrier gas during a programmed temperature run.

Control of the variables discussed above is sufficiently good to give repeatability of ± 1% of both peak heights and retention times in temperature-programmed gas analyses.

F & M's Model 500 helped re-open the field of gas-solid chromatography —once nearly abandoned because of the isothermal requirements for multiple columns and multiple detectors in series. For further information about this versatile instrument, write or call F & M's home office or any of the district offices listed below.

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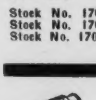

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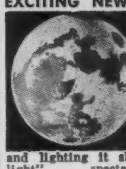

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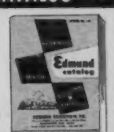

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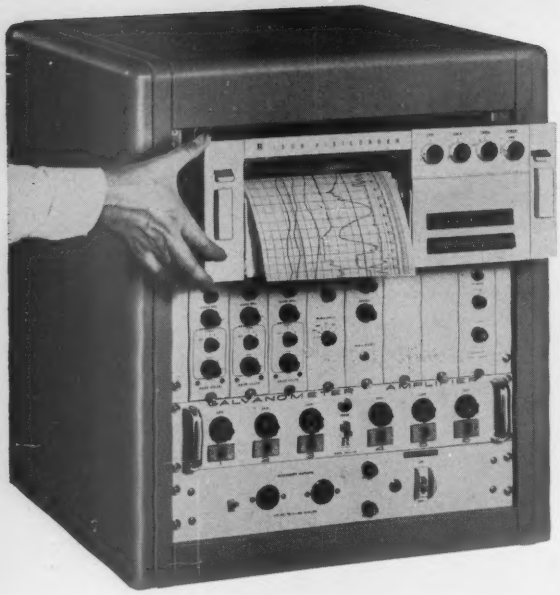

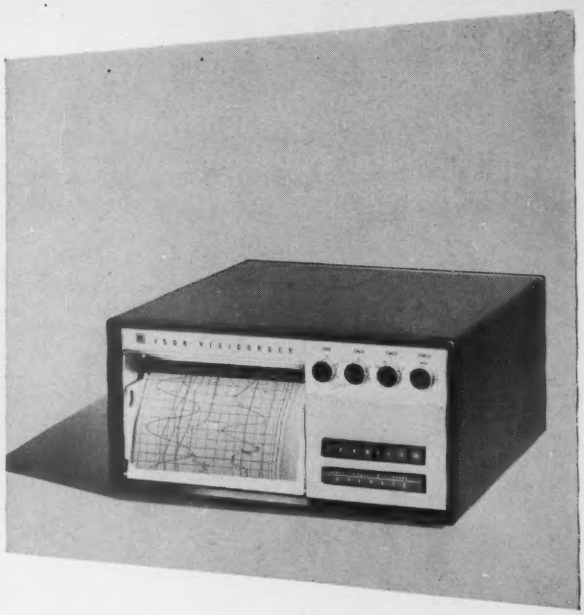

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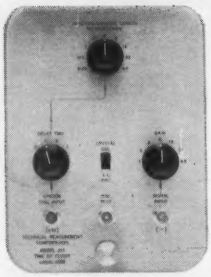

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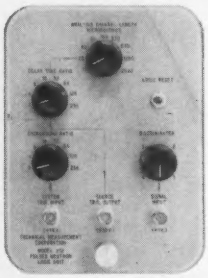

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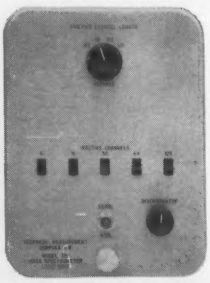

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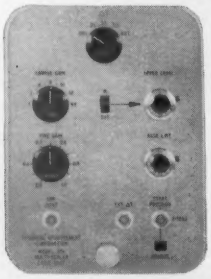

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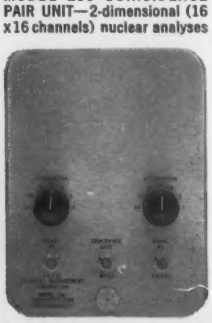

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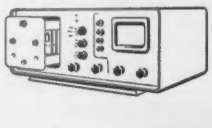

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Poverty's Millionaires

It seems fair to assume, in thinking about technical assistance to underdeveloped regions, that a man whose daily diet consists essentially of two meals of rice, hot in the evening and the cold remains in the morning, needs no one to tell him that he wants more to eat. Yet that there are men in just this circumstance who do need such advice is one of the paradoxes of technical assistance described by Kusum Nair in her recent book *Blossoms in the Dust* (Duckworth, London). The author, an Indian journalist, spent a year, as she says, as a "nobody," visiting a sample of India's rural communities to determine the expectations and attitudes of some of the people on the receiving end of India's development effort.

In the example just cited, Kusum Nair asked the untouchables of one community—they were the persons who, for hire, actually worked in the fields—how much land they would want if the government were to give it to them free. The replies: Samu, five in the family, 1⅓ acres; Rangarajan, five in the family, 2 acres; Manickam (the exception), six in the family, 5 acres; Srinivasan, four in the family, 2 acres; and so on and on. Actually, these replies were calculated not on the basis of ownership but on that of a system of tenant farming. The acreage asked for was supposed to provide, for each member of the tenant's family, the requisite two square meals of rice a day, and to allow for giving about half the produce to the owner of the land.

The section of the country to which this community belongs is at least distinguished by its enthusiasm for irrigation. In another section, one in which millet is grown and in which rain is the traditional source of water, the great majority of land owners would not use the water made available for irrigation by a new hydroelectric project, even when despairing project officials offered to let it into the fields for them. With a yield sufficient for local consumption, the owners are more impressed by the increased cost and effort required for increased production—the use of irrigation, for example, also requires the use of fertilizer—than by the resulting increase in production.

Although the book is concerned with India's problems with her rural communities, the lesson taught by what the author calls "poverty's millionaires" may apply as well to American programs of technical assistance to other countries. The lesson is that when the technical mission returns from the field with its recommendations as to where to place the dam and where to string the power lines, the job of planning is only half done. Attention must be paid not only to the physical resources of a region and to how those resources might be utilized, but also to the attitudes held by the natives of the region and to how those attitudes might be changed.

Moreover, just as there is no universal development plan suitable for all regions, so there is no universal method of persuasion suitable for all communities. The book catalogs a great variety of responses to technical assistance, including among them even enthusiasm. It is heartening to note that in one particularly primitive section of India there were villagers who, in rice cultivation, as soon as they were introduced to the plow, demanded the bulldozers of which they had dimly heard, in order to clear land more rapidly.—J.T.

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8 December 1961, Volume 134, Number 3493 SCIENCE

Cohesive Lift of Sap in the Rattan Vine

The problem of how sap rises lies stranded for lack of means to measure negative pressure in liquids.

P. F. Scholander, E. Hemmingsen, W. Garey

The rise of sap in tall trees has puzzled plant physiologists and laymen alike for more than a century. The cohesion theory of Dixon and Joly (*1*) and Askenasy (*2*) is generally accepted as the principle involved, and, indeed, no other likely explanation has been forthcoming. It is postulated by this theory that evaporation from the leaves pulls the transpiration stream through the tree by virtue of the cohesive property of water. If this is true, the sap pressure in the top of a tree 100 meters tall should be some −20 atmospheres, for, in addition to the hydrostatic gradient of 1 atmosphere per 10 meters, one needs a similar pressure drop in order to sustain the transpiration flow (*3*).

This "wick theory," as it has also been called, carries a special fascination in that it seems incredible that water, which cavitates so readily when evacuated in a flask, should flow with impunity through intricate channels at a pressure which is negative by many atmospheres. And yet, it is easy to show that water possesses this elusive potentiality, provided it is confined within capillary dimensions. This was already indicated by the classical experiments on the cavitation pressure in fern sporangia (*4*) but was given a firm quantitative foundation by the direct and elegant centrifugation technique introduced by Briggs (*5*). By spinning boiled water in *Z*-bent capillaries at ultrahigh speed (Fig. 1*A*), he found that it would withstand −260 atmospheres before rupturing. Using an ordinary laboratory centrifuge, one may produce −20 atmospheres, but even air-saturated tap water will not cavitate at this tension, provided the capillary is no wider than half a millimeter.

What then is the evidence that negative pressures of such magnitude may occur in plants? The most convincing support was contributed by the noted German plant physiologist Otto Renner in 1911 (*6*). He connected a leafy twig to a burette and, by compressing the stem with a screw clamp, forced the leaves to exert their maximal pull (Fig. 1*B*). When the leafy top was cut off and a vacuum line was attached in its place, the rate of flow decreased to one-tenth. The conclusion from this beautifully simple experiment seems inevitable—namely, that the leaves must have imparted a pull of 10 atmospheres on the sap. By a slight modification of technique Renner was also able to show that a few atmospheres negative pressure may well obtain in a twig still attached to the tree (*7*). Using in principle the same line of approach, many later authors have confirmed and extended these findings.

If liquid under tension prevails in the stem, what prevents the sap from cavitating? If the sap cavitates, what prevents the vapor lock from spreading? Both of these questions seem answerable in terms of the anatomical design of the conductive system. Basic to all trees is the tracheidal structure, which forms a continuous tissue of minute spindle-shaped chambers 20 to 80 microns wide. In conifers this is the only system, but in hardwoods the flow is aided by vessels, which in some species (especially vines) may be as much as half a millimeter wide. These tubes are partitioned by cross walls, which may be a few centimeters to several meters apart, according to species. The walls of all structures are studded with microscopic perforations (pits), and the sap flows through the various compartments in a continuous capillary meshwork. Should negative pressures develop, nucleation would be inhibited simply by the fine dimensions of the channels. It is of particular interest that the pits are closed by a water-pervious membrane of such fine porosity that a gas interphase cannot pass—that is, the flow system is completely check-valved from one compartment to the next with respect to gas passage. The problem of transporting water at high negative pressure over a long distance has thus been solved by combining capillary dimensions with check-valved compartmentalization; in fact, we doubt that any other solution is even theoretically possible.

One may test the function of these structures on a cut liana taking up water from a burette. When the stem is suddenly removed from the water, the air at first follows the receding water columns but soon comes to a complete stop—that is, when the menisci are caught in the membranes of the first cross walls. It is quite obvious

The authors are affiliated with the Scripps Institution of Oceanography, University of California, San Diego.

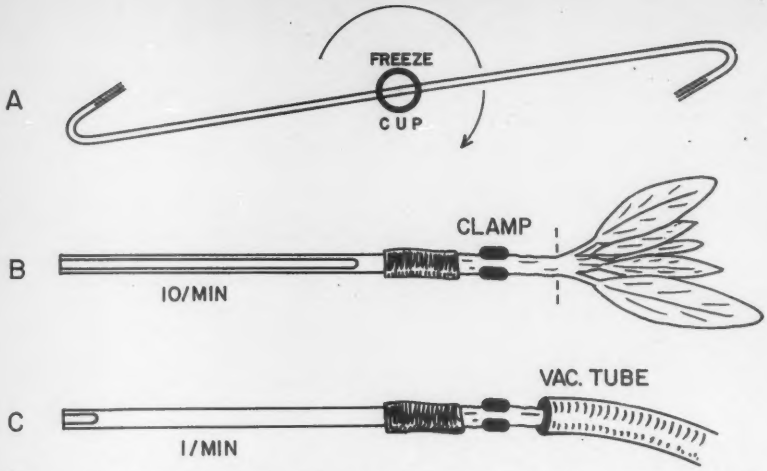

Fig. 1. *A*, Water-filled capillary spinning in a centrifuge to produce tensile water (*5*); *B*, leafy twig with clamped stem, taking in water from a capillary at a rate of 10 volume units per minute; *C*, vacuum tube drawing water through the same stem at a rate only one-tenth that of the leaves (*6*).

that, when a twig or branch breaks off, air does not penetrate beyond the wounded area, for none of the adjacent structures wilt. Nevertheless, Bailey (*8*) found that fresh xylem, when removed from various conifers 25 meters above ground, would let air through at a pressure of less than 3 atmospheres. Does this mean that the air penetrated through nonfunctional channels, or could it be that the sap pressure in the top of the tree was nowhere near the predicted −5 atmospheres? Another discordant finding was that of Ursprung (*9*), that leaves from locust trees wilted when the twig was forced to draw water maintained under reduced pressure. What was the reason?

When the cross-section area of a stem is drastically reduced by cutting, the rate of water uptake may remain practically unchanged. This may seem to be a case of lavish overprovision of flow channels, but it is evident that the compensation takes place only at the cost of a pressure drop above the restricted area, which may amount to several atmospheres (*10*). So, although the evaporation pumps are powerful enough to restore normal flow, the entire system must suffer stress in terms of abnormal tension.

It is inherent in any simple static cohesive system that there must be an exact hydrostatic gradient throughout, but, inasmuch as we still lack a method for measuring negative pressures with any accuracy at all, this, the most fundamental parameter of cohesive lift, remains unverified. At positive pressures, however, such as exist in the grapevine in the springtime before the leaves unfold, direct manometric measurements are easy to make, and these have revealed an exact hydrostatic gradient from the ground level up, irrespective of the general pressure level (*11*). So in this case, at least, we are dealing with a simple hydrostatic system, and we need not invoke any unknown lifting force in the stem. If this situation is extrapolated to negative pressures, which seems a reasonable enough step, it must be taken into account that such a system would be badly damaged if extensive cavitation were to occur. If, for instance, the entire cross section of a stem could be artificially cavitated in a region of negative pressure, the transport system should become vapor-locked, and sap flow should cease.

Vapor Lock Produced by Freezing

When water freezes into ice cubes in the refrigerator, the dissolved gases are dispelled as bubbles, for ice has no perceptible solubility for gas (*12*). Similarly, when water is frozen in a glass capillary and thawed, a string of bubbles is left in the capillary, and it takes days for these to redissolve into the water. Finally, if a capillary bent into a *Z* is filled with water and set to spin in a centrifuge, according to the method of Briggs, the water cavitates immediately when the midsection is frozen by a piece of Dry Ice (Fig. 1*A*) (*13, 14*). Freezing, therefore, offers an opportunity to cavitate the sap within an intact vine (*15*).

During an expedition of the Scripps Institution of Oceanography to the Torres Strait area in 1960, an opportunity developed to perform a series of experiments on rattan vines (*Calamus*) growing in the jungle near Cairns, Queensland. The rattan cane of commerce is the climbing stem of several species of palm. The stems originate in a basal leaf rosette, and, climbing through the foliage by means of hooked flagellae, they commonly reach the canopy of the tallest jungle trees, some 30 to 50 meters aloft. Evidently the stem grows faster than it climbs, for loops 10 to 20 meters long are regularly found lying on the ground. This feature, among others, made the rattan an ideal material for a crucial test of the embattled cohesion theory. The plan was to cavitate such a ground loop by freezing. The loop would then be elevated 11 meters, and when it thawed it should remain vapor-locked, so that sap could not pass. Several experiments were performed, all with similar results. We shall here describe only the latest and most complete of these.

A loop of vine was put into a basin, and the stem was cut off under water with pruning shears. While under water, the vine was connected with a graduated glass tube through a rubber hose, and the assembly was clamped to the base of a small tree. The vine (1.5 to 2 cm thick) was then taking up water at the rate of 12 milliliters per minute. The stem was fitted tightly between two grooved pieces of Dry Ice, but whatever peripheral freezing took place did not even slow down the rate of uptake. Neither did the rate slow down when the burette was filled to the brim with water and stoppered; the water simply vacuum-boiled and disappeared at undiminished rate (*11*). From this it was already clear that we were dealing with tensile forces in the stem. By letting air into the stem, the flow was finally stopped, and the vine froze solid. A section 2 meters long, containing the air, was excised under water, and the vine (with its frozen section) was reconnected with the burette.

The experimental results are shown in Fig. 2. The normal drinking rate before freezing was 12 ml/min (*A*). With

the stem frozen across, it was zero (*B*). When the loop with the frozen section was hoisted 11 meters in the air, the burette gained 26 milliliters, and no drinking ensued when the section was thawed (*C*) (*16*). Clearly, therefore, the freezing had cavitated the sap, which was then free to drain down by gravity until balanced by barometric pressure. From the experiment with the stoppered burette mentioned above, we must assume that the nearest vessel compartments above the ice were likewise emptied and vapor-locked, in this case by the transpiration pull; that is, the vine was vapor-locked through the gravity pull from below and through the transpiration pull from above. When the loop was lowered to the ground (*D*), water consumption was promptly resumed, and, after an initial excess intake of 20 milliliters, the rate settled down to a steady 20 percent of the initial rate. The excess intake is a measure of the collapse of the lower vapor lock, and the reduced steady-state rate signifies that the vapor lock did not collapse completely. The latter finding may readily be explained as a result of the flow resistance in the 15 meters of vine which separated the burette from the cavitated section. In any event, when the burette was elevated 11 meters, the vapor lock evidently collapsed, for full drinking rate was resumed (*E*). When finally the cavitated section was excised, the drinking rate remained unchanged.

These experiments furnish evidence for cohesive lift and a normal hydrostatic gradient in tall rattan vines, for such vines take up water at an undiminished rate from an evacuated vessel and, when a bubble-seeded section of the vine is elevated above barometric pressure (10 m), the sap columns vapor-lock and transpiration flow stops.

Freezing of Northern Forest Trees

If the ascent of sap in tall trees is caused by cohesive lift of liquid under tension, cavitation of the sap could be utterly destructive to the transpiration flow. But if freezing is so devastating to the rattan vine, one must ask: What happens then to the northern trees in the wintertime? Do they freeze, or do they become supercooled? If they remain supercooled, why are they not triggered into freezing by ice and snow?

Calorimetric determinations of freezing in the xylem of several species of northern trees showed that, without exception, they regularly froze, even at very moderate temperatures. Thus at −6° to −10°C, all free water was frozen, with only a small fraction, corresponding to 30 to 40 percent of the dry weight, left unfrozen and bound to the cellulose (*14*). In other words, all free water in tracheids and vessels freezes regularly and, hence, triggers gas seeding throughout the tree. Since freezing and thawing take place repeatedly during the winter season, it is clear that cohesive tension cannot exist at this time. Only a few species of hardwoods and lianas, such as birch and grapevine, respectively, are known to have, in the springtime, a short period of stem pressure high enough to mend gas breaks. Isolated roots of conifers develop positive sap pressure, but this seems to build up too slowly to be of much help (*17*). Undoubtedly, our knowledge on this problem is very incomplete.

Sap Flow in the Sugar Maple

We found in the rattan vine that cavitation, induced by freezing above 10-meter elevation, caused sap to flow out at ground level. It is natural to link this translocation with the flow of sap from maple trees when these are

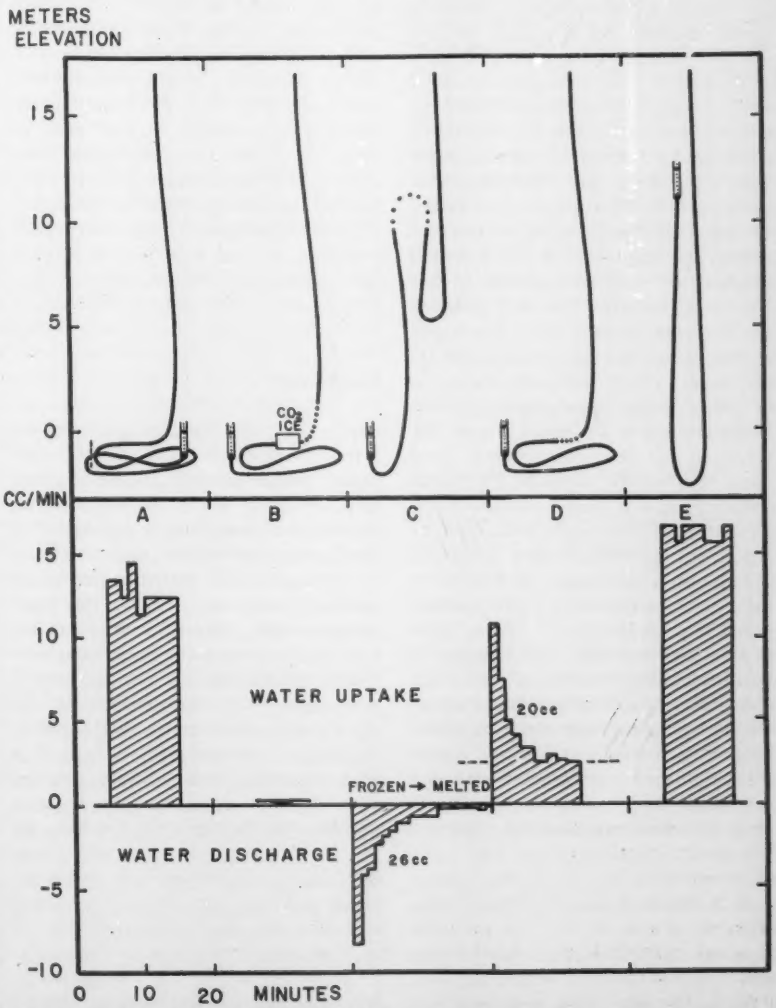

Fig. 2. Water intake by a rattan vine: *A*, before freezing; *B*, frozen; *C*, with nucleated loop elevated 11 meters; *D*, with cavitated section on ground; *E*, with burette elevated 11 meters. Dotted line, cavitated section.

punctured during the first thaw after winter freeze. The sap is then bubble-seeded throughout the tree and is, accordingly, free to drain down from the upper parts sufficiently to build up a positive hydrostatic gradient in the lower parts of the stem. There can be little doubt that this sort of situation exists in maples and other trees when the frozen sap melts in the spring. But the mere fact that so few species display a "sap run" indicates that this controversial old problem is more complex than it appears (*18*).

Sap Cavitation and Cosmic Radiation

Another interesting implication of the sap-rising problem is the possible detrimental effect of cosmic radiation upon sap under cohesive tension. Glaser's bubble chamber for the study of elementary particles was developed upon the principle that ionizing radiation will nucleate a superheated liquid to form bubbles, analogous to the condensation tracks formed in supersaturated water vapor in the Wilson cloud chamber (*19*). Now, especially during drought, tall trees and other vascular plants are supposed to develop sap pressures of −10 atmospheres or less [−143 atmospheres has been claimed for a desert shrub (*20*)]. The vapor tension is, at the same time, positive, of course, so that technically the sap is in a highly superheated, explosive state. If these tensions are really normal for tall trees and dehydrated plants, what happens when the sap is hit by cosmic radiation? Is it triggered into cavitation or not? This possibility was tested by irradiating thin-walled glass capillaries spinning in a centrifuge. In a series of such experiments, where water was subjected to pressure of −20 atmospheres, it was demonstrated that sodium-22, dissolved in the water and giving approximately 10 disintegrations per second at the central part of the capillary, did not promptly cavitate the water. Neither did the vastly more powerful ionization from a close-range therapeutic x-ray tube, nor ionization from a therapeutic cobalt-60 source. So there seems to be no obvious contradiction between tall trees and cosmic radiation.

Life under Metastable Conditions

The condition of superheated sap in plants represents the most striking instance known of the invasion by evolutionary processes of a region of physical metastability. It is not the only case, however, for a few years ago a population of supercooled fish was found living at the bottom of Hebron Fjord in Labrador, 100 to 200 meters deep. The temperature of the bottom water in this fjord remains constant the year round at about −1.7°C and the freezing point of the blood of fishes living in this water is near −0.7°C—that is, the fishes are supercooled by nearly 1°C. If they are brought to the surface and touched with a piece of ice, freezing is triggered and ice propagates readily through their bodies and kills them. They can flourish where they are solely because there is no ice at the bottom, which could seed them into crystallization (*21*). In contrast to these fishes, plants are less vulnerable with respect to their metastable condition, for they have built-in protection against both nucleation and gas propagation.

Conclusion

It is clear that the bioengineering of a tree is amazingly suited to deal with liquid under tension. However, the mechanism by which the plant copes with certain situations is incompletely understood. Nucleation and cavitation are a regular part of the life cycle of northern forest trees. How is this massive gas seeding mended, and is it really true that a redwood or eucalyptus 100 meters tall maintains a sap pressure at the top of −20 atmospheres? We do not know by direct measurements what hydrostatic pressures the transpiring plant must buck in the soil, nor can we, with any accuracy, measure negative pressures in the trees. So, we have no direct knowledge of hydrostatic gradients in these structures. There is little reason to doubt that a variety of microporous structures, such as clay, soil, xylem, or gelatine, may become squeezed by the cohesive forces of the enclosed water, but the empirical study of all of these phenomena is deadlocked by lack of accurate measuring techniques.

The free-for-all, charming old problem of how sap ascends tall trees still presents a wealth of unsolved questions to challenge the experimental ingenuity of future workers (*22*).

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The Search for Signals from Other Civilizations

The waiting time for answers may be greater than the longevity of the technical state of mind.

Sebastian von Hoerner

A search for extraterrestrial signals from an intelligent source should be guided by two estimates, one of the probable nature of such signals and the other of the distance from which they might come. We cannot search for something without at least a rough idea of what to look for, and we cannot detect an object if the range of our means of perception is too short. The present article (*1*) is concerned in large part with the distance. The objective in making such estimates is not to make statements about other civilizations but solely to lead to a working hypothesis which could guide a search.

Because we have no knowledge whatsoever about other civilizations, we have to rely completely on assumptions. The one basic assumption we want to make can be formulated in a general way:

> Anything seemingly unique and peculiar to us is actually one out of many and is probably average. (1)

As a demonstration of the power of this method one can show that even the ancient Greeks could have estimated the distance of the sun from the earth, and even the distance between neighboring stars, if they had just applied the foregoing assumption to the earth, assuming it to be an average planet, and to the sun, assuming it to be an average star. They would have assumed that the earth was of average diameter, albedo, and distance from the sun; comparison of the average apparent brightness of the five known planets with that of the sun, together with the Greeks' knowledge of the diameter of the earth, would have given them a distance to the sun which is too large by a factor of 2. They would have assumed that the sun had average absolute brightness; comparison of the average apparent brightness of the ten brightest stars with that of the sun, together with the distance of the sun as derived above, would have yielded a distance between neighboring stars which is too small by 5 percent.

All that is needed in this approach is the right classification and one absolute value to start with (in the foregoing examples, the diameter of the earth). The resulting estimate can be, of course, completely wrong, but the probability that it will be is very small, and the probability that the result will be right is high. This is the best we can demand.

The basic assumption in the present article is that our planetary system and our civilization are about average and that life and intelligence will develop by the same rules of natural selection wherever the proper surroundings and the needed time are given. This includes the assumption that the average civilization will reach our present level of intellectual concern or state of mind (science, technology, search for interstellar communication) after about the same length of time as we did and will face about the same difficulties as we do. However, we should also assume that our present state of mind is just one of many possibilities and that it will be succeeded by other interests and activities.

We should not underestimate the power of two critical factors that can terminate the life of a civilization once the technical state has been reached. Science and technology have been brought forward (not entirely, but to a high degree) by the fight for supremacy and by the desire for an easy life. Both of these driving forces tend to destroy if they are not controlled in time: the first one leads to total destruction and the second one leads to biological or mental degeneration. In summary, we assume that a state of mind not too different from our own will have developed at many places but will have only a limited longevity.

Distance between Civilizations

All of the following quantities are supposed to be average ones within a solar neighborhood of, say, 1000-parsec radius (*2*). We call v_0 the fraction of all stars which have planets where life can develop, T_0 the time needed to develop a technical civilization (defined, for example, by the presence of highly advanced radio techniques), l the longevity (*3*) of the technical civilization, T the age of the oldest stars, and ν the fraction of all stars which at present have a technical civilization. If we assume, for the present purpose, that the rate of star formation has been constant over the time T, we then have

$$\nu = \begin{cases} v_0 (T - T_0)/T & \text{if } l \geq T - T_0 \\ v_0 (l/T) & \text{if } l \leq T - T_0 \end{cases} \qquad (2)$$

If we call D_0 the mean distance between neighboring stars, then the mean distance between neighboring technical civilizations, D, is given by

$$D = D_0 \nu^{-1/3} \qquad (3)$$

In order to obtain the average longevity l, we have to go into some detail. We adopt the following five alternatives by which the longevity of a technical civilization (or of its technical state of mind) might be limited: 1) complete destruction of all life; 2) destruction of higher life only; 3) physical or mental degeneration and decay; 4) loss of interest in science and technology; 5) no limitation at all. In cases 2 and 3, another civilization might develop on the same planet out of the unaffected lower forms of life, and we assume that the time needed for such recurrence is small compared with T_0. Now, we call $l_1 \ldots l_5$ the average longevity in the above five

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alternative cases and $p_1 \ldots p_5$ the probability of their occurrence. If $l_1 \ldots l_4 \leq T - T_0$, we have

$$v = v_0 \{ [(p_1 l_1)/T] + \ldots + (p_4 l_4/T) + p_5(T - T_0)/T \} \times [1 + (p_2 + p_3) + (p_2 + p_3)^2 + \ldots] \quad (4)$$

or

$$v = v_0 Q(l/T) \quad (5)$$

with the average longevity l defined by

$$l = \sum_{i=1}^{4} p_i l_i + p_5(T - T_0) \quad (6)$$

and a recurrence factor Q, defined by

$$Q = 1/[1 - (p_2 + p_3)] \quad (7)$$

Another interesting question is the following: At what stage are the first civilizations we meet most likely to be? We call t the time from the beginning of their technical phase (defined by advanced radio techniques) to the present. The probability that the first civilizations we contact will be of group i is given by $P_i = v_i/v$, and their average "technical age" at the moment of contact is $t_i = l_i/2$. The most likely value for their technical age, then, is

$$t = \Sigma P_i t_i = (\Sigma\, p_i l_i^2)/2l \quad (8)$$

The probability is

$$p_r = p_2 + p_3 = (Q - 1)/Q \quad (9)$$

that there will have been other civilizations before them on the same planet.

The foregoing analysis seems to be fairly straightforward up to this point, but it tends to become a matter of personal opinion when one begins to adopt numerical values for the average longevities, l_i, and the probabilities of occurrence, p_i, of the various alternative cases. As a justification for doing so at all, I mention two arguments. First, one cannot design an adequate receiving system without some estimate of this kind. Second, the uncertainty of l enters Eq. 3 only with the power 1/3:

$$D \sim l^{1/3} \quad (10)$$

In Table 1 appear the values which in my opinion are the most likely ones, and for the sake of brevity I omit all the long discussions which led to these values ($p_5 = 0$, for example, means that I do not believe in this one at all). Maybe this very subjective guess seems a little pessimistic, but I want to be on the safe side. From these values we find

$$l = 6500 \text{ years} \quad \text{and} \quad Q = 4 \quad (11)$$

If we adopt $T = 10^{10}$ years, $v_0 = 0.06$ [somewhat less than the estimate of Su Shu Huang (*4*)], and $D_0 = 2.3$ parsec (as the average distance of the ten nearest stars from the sun), we get

$$v = 2.6 \times 10^{-7} \quad (12)$$

as the fraction of stars which have technical civilizations at present, and

$$D_0 = 360 \text{ parsec} \quad (13)$$

as the average distance to the ten nearest technical civilizations. Furthermore, we find from Eq. 8 that the first civilization we receive signals from will have a most probable "technical age" of

$$t = 1.2 \times 10^4 \text{ yr} \quad (14)$$

and thus will have weathered the first crisis (destruction) a long time ago; and there is a probability of

$$p_r = 75 \text{ percent} \quad (15)$$

that it will be the successor of older, extinct civilizations on the same planet. On the other hand, the chance of meeting a civilization in exactly the same phase that we are in [still confronted with the crisis of destruction (groups $i = 1$ and $i = 2$)] is only 0.4 percent. Finally, we define the average longevity of the most frequent civilizations by $L = 2t$ and obtain

$$L = 2.4 \times 10^4 \text{ yr} \quad (16)$$

First Conclusions

As mentioned earlier, this estimate should be regarded only as a working hypothesis for the purpose of guiding a future search for extraterrestrial signals. If we assume that the values adopted in Table 1 are not too wrong, and if we neglect the "feedback effect" discussed in the next section, we can draw the following conclusions.

1) The value $v = 2.6 \times 10^{-7}$ means that only one in 3 million stars will have a technical civilization, and this implies that we cannot search for signals from a certain number of individual, conspicuous stars; we must scan the whole sky continuously.

2) This value also implies that no other civilization will send contacting signals (intended to attract attention and to establish contact) in the direction of our sun as one of the conspicuous stars. But such contacting signals might be sent from beacons in all directions over the whole sky.

3) The value $D = 360$ parsec means that the antenna-receiver system to be used for a search should be able to reach a distance of at least, say, 400 parsec, and this also demands an estimate of the probable nature of the signals and the power emitted.

4) The civilizations we find will very probably be much older than we are, and they will be more advanced. Our chance of learning from them might be considered the most important incentive for our search.

5) Since 360 parsec is about 1000 light years, the waiting time t_w for an answer to a question will be about 2000 years on the average; this implies three consequences: (*a*) the contacting signals would already contain messages (including an introduction to a language); (*b*) there would be no need to hurry in "speaking," and relatively slow pulses might be used; (*c*) there might be some "speaking" and "listening," but "mutual exchange" of ideas would be rather limited because of the long time scale involved.

Possible "Feedback" Effect

The mutual exchange of ideas just mentioned leads to the consideration of a feedback effect of the longevity, via radio communication, on itself. Suppose that the estimated value for the (unaffected) longevity l (Eq. 11) is too large, so that in reality the waiting time for answers, t_w, is greater than the longevity of the technical state of mind. Then nobody will ever get an answer to his call. Some still-hopeful civilizations (after having made too optimistic an estimate for l) might, for a while, send signals which might be picked up occasionally by others. But if the search for signals, on the average, is not successful, then loss of interest will usually come soon. This we call case *A*. On the other hand, suppose that our estimated value of l is too small and that a real exchange is possible. This will have a tendency to keep interest alive over a very long period and might even lead to civilizations' helping one another to solve problems and weather crises. This we call case *B*. Thus, in my opinion, there is a high likelihood that there will be either no exchange or a great deal, but a low likelihood of an in-between situation. A small amount of exchange is, so to speak, a nonequilibrium state. Unfortunately, our

estimate for the unaffected longevity just happens to fall into this unstable region, so it is hard to tell which one of the two alternatives is the one which will prevail.

The governing quantity in this problem is the ratio of the average longevity of the most frequently occurring civilizations, L, to the average waiting time for answers, t_w. This ratio is

$$K = L/t_w \qquad (17)$$

where $L = 2t$, t is given by Eq. 8, and $t_w = 2D/c$ (c is the velocity of light). From the values of our estimate (Eqs. 13, 14, and 16) we obtain

$$K = 10.2 \qquad (18)$$

Ten conversations per lifetime of a civilization would mean some exchange, but not much, and the question still remains open whether this is enough to trigger, through feedback, case B. In order to show more clearly in what way the quantity K depends on the assumptions made, we write

$$K = c/2D_0[v_0Q)^{1/3}(\Sigma p_i l_i^2/T^{1/3}l^{1/3})] \qquad (19)$$

and for simplicity we will assume that, from the various alternate groups of Table 1, only one group, index k, has a high value of the product $p_i l_i$ as compared with the values for the other groups. We then have $L = l_k$ and

$$K = (c/2D_o)(v_oQp_k)^{1/3}(L^{4/3}T^{1/3}) \qquad (20)$$

We see that, unfortunately, the most uncertain quantity, L, enters with a high power, while the remaining somewhat less difficult quantities Q, v_o, and p_k enter only with the power 1/3. Therefore, we throw all uncertainty into L and write

$$K = (L/L_o)^{4/3} \qquad (21)$$

with a critical longevity L_o defined by

$$L_o = (8D_oT/c^3v_oQp_k)^{1/4} \qquad (22)$$

If we use the values $D_o = 2.3$ parsec, $T = 10^{10}$ yr, $c = 3 \times 10^{10}$ cm/sec, $v_o = 0.06$, $Q = 4$, and $p_k = 1/3$, Eq. 22 finally gives

$$L_o = 4500 \text{ yr} \qquad (23)$$

Because of the exponent 1/4 in Eq. 22, I think the value for the critical longevity (Eq. 23) should not be too far wrong. Everything depends, then, on the question of whether the unaffected longevity is great compared with 5000 years. If it is, the feedback will be triggered, generating case B, and this will increase the longevity L considerably, up to some limiting value L_m.

At this point, however, we have reached the limit of our method of estimate, because, having had no communication with other civilizations, we have nothing to start with and we cannot know how strong the effect of the feedback will be. It is purely a personal belief if we think that L_m will not be higher than, say, a million years and that it will probably be much less than that.

In order to illustrate the variation of the different quantities with the longevity L, I have made some calculations, with the results given in Table 2. Using the values that we used for Eq. 23, we get

$$\begin{aligned} v &= v_oQp_kK/T = L/(1.25\text{x}10^{11} \text{ yr}); \\ D &= D_o/v^{1/3} = 2.3 \text{ parsec}/v^{1/3}; \\ K &= (L/L_o)^{4/3} = (\text{L}/4500 \text{ yr})^{4/3}; \\ t_w &= 2D/c = 15 \text{ yr}/v^{1/3} \end{aligned} \qquad (24)$$

I wish to emphasize that the longevity L is the one extremely uncertain quantity, while all the other quantities in Eqs. 24 may be trusted to a fair degree. Thus, whatever L we choose requires that the answers of Table 2 for this L then be accepted.

Especially, we must accept very long waiting times t_w (of at least 1000 years and probably more) if L is to stay within reasonable limits, and this is a rather disappointing result. It means that the feedback and case B can be triggered only if the more highly advanced civilizations are able to think, to plan, and to act in terms of thousands of years. This is extremely different from our own situation, in which we would be happy if we could solve the problems of the next 5 years. But it is not impossible, either, that natural selection and increasing good sense might work in this way. Furthermore, even if the average value for K is too small to trigger case B, there might be large fluctuations of K in time and space; if the feedback has triggered case B once somewhere, the resulting effect then would tend to go on in time and to expand in space. It is amazing how similar this seems to be to the problem of the origin of life in general (and one might feel a strong temptation to draw some more parallels).

In summary, I think that the feedback effect will play an important role, in one direction or the other. The basic idea is just that of giving up if one is disappointed and of increasing the effort if one is successful. But I am unable to say in which of the two directions the effect is more likely to be felt. We expect to find either a high activity in communication at shorter distances (200 to 300 parsec) between civilizations of extremely long time scales (case B) or very little if any activity at greater distances (600 to 1000 parsec) from civilizations similar to our own (case A). We should be prepared for both possibilities.

Table 1. The most likely values for l_i and p_i (see text).

Alternative	Estimated range for l_i (yr)	Value adopted: l_i (yr)	Value adopted: p_i	p_il_i (yr)
Complete destruction	0–200	100	0.05	5
Destruction of higher life	0–50	30	0.60	18
Degeneration	10^4–10^5	3×10^4	0.15	4500
Loss of interest	10^3–10^5	10^4	0.20	2000
No limitation	$\geqq T - T_o$	$T - T_o$	0.00	0

Table 2. Variation of $1/v$, D, t_w, and K with longevity L (see text).

L (yr)	$1/v$	D (parsec)	t_w (yr)	K
100	1.3×10^9	2,480	16,200	0.006
300	4.2×10^8	1,720	11,200	.027
1,000	1.3×10^8	1,150	7,500	.13
3,000	4.2×10^7	796	5,190	.58
10,000	1.3×10^7	534	3,480	2.9
30,000	4.2×10^6	370	2,420	12.4
100,000	1.2×10^6	248	1,620	61.7
300,000	4.2×10^5	172	1,120	268
1,000,000	1.2×10^5	115	750	1,330

Second Conclusions

If the feedback plays the role we think it will, then some of our first conclusions must be modified. Because we cannot decide as to the direction of the feedback, both possibilities must be considered.

1) No essential change is needed for Nos. 1, 2, 4, 5*a*, and 5*b* of our first conclusions; we cannot search for single stars, and nobody sends messages to us especially; the civilizations we meet will be much more advanced than we are, and contacting signals will already contain messages which might use relatively slow pulses.

2) Our receiving system should be able to reach a distance of either 200 to 300 parsec in case *B* or of 600 to 1000 parsec in case *A*.

3) In case *A* there would be little or no interstellar communication. In case *B* we should expect a highly developed communication system and much activity.

4) According to the law of natural selection, a variety either has the will and the ability to maintain itself or it soon dies out. Thus, if the feedback effect has triggered case *B* and *still* maintains case *B*, this implies that some effective means exist for "beginners" to establish contact with other civilizations (contacting signals).

Nature of the Signals

In order to have a reasonable hope of success, we should be guided in our search by a definite idea of what to look for. This idea might turn out to be wrong, and we would then have to start with a better one. But it seems hopeless to search the whole sky, all the time, over all frequencies and with extremely narrow bandwidth, just for "something."

I suggest that we assume that the nature of the signals will be defined entirely by two things: (*a*) the purpose they serve; (*b*) the most economical way to achieve it. Both of these we might be able to guess. The argument that other civilizations could be completely different does not help at all in guiding a search, even if it is true, whereas the foregoing assumption will lead to a definite program, even if it is invalid; only by trying can we tell whether it is valid or invalid. To summarize, I think that a search has a fair probability of success if it is guided by the best guess we can make, but almost none if it is made without a definite plan. The following considerations are very incomplete and tentative; my main purpose in proposing them is to stimulate the formulation of better ones that finally could be used.

As to the purpose, we can think of three general possibilities: local communication on the other planet, interstellar communication with certain distinct partners, and a desire to attract the attention of unknown future partners. Thus, the things we should look for we might call local broadcast, long-distance calls, and contacting signals. The local broadcast has the highest likelihood of existing but may be extremely difficult to detect because of its relative weakness. Long-distance calls would not be intended for us but might hit us just by chance; the probability is small, however. Contacting signals would be intended for exactly the kind of search we plan to make, and therefore they should have the highest probability of detection, provided they do exist. Local broadcasts would exist in both cases *A* and *B*, as defined earlier, while long-distance calls and contacting signals would exist in case *B* only.

As to the frequencies used, those for the local broadcast might be not too different from our own, but for communication over interstellar distances, the range of frequencies would be limited by considerations of economy. Drake (*5*) calculated the combined influence of galactic and atmospheric noise and found a broad minimum between 1000 and 10,000 megacycles. In a recent paper (*6*) Drake finds, even for sending and receiving from above planetary atmospheres, a very general rule for defining the most economical frequency. It should lie in the range from 1000 to 30,000 megacycles per second, most probably at about 10,000 megacycles per second ($\lambda = 3$ cm), a frequency which still could be observed from within our atmosphere.

Drake (*6*) has pointed out that the local broadcast would occupy a large number of narrow channels, distributed over a larger frequency range. He has worked out a very effective method of detection, a cross-correlation between two independent frequency scans. This method is not concerned with the single signal, with its frequency or its strength, but answers with increased sensitivity the question of whether or not there are a large number of signals at the same frequencies in both scans. This is the first thing to ask.

As for long-distance calls, we have estimated the probability of the earth's being hit by one. Because the answer is not very encouraging I shall skip the details and just give the result. If each civilization speaks, on a permanent basis (and listens, as well), to a number n of its neighbors, if the messages are sent with beamwidth β, and if we are able to detect these signals at q times the distance to which they are sent ($q > 1$ because detecting is easier than understanding), then the probability of our being hit by chance is about

$$P = (\pi/120)\, q^5 \beta^2 n^2 \quad \ldots . \quad (25)$$

a value which is independent of L and D.

If we regard $P = 1/2$ as sufficiently large to warrant a search and regard $q = 5$ and $\beta = 1$ minute of arc as likely values, this would require that each civilization should speak, on a permanent basis, with $n = 1300$ others, and it seems very unlikely that this is the case. But if we regard $n = 50$ as a reasonable value, we would then need the somewhat extreme values $q = 10$ and $\beta = 10$ minutes of arc, which, again, are unlikely. Because all the unknown quantities enter Eq. 25 at high powers, we think that a chance hit is highly unlikely (though not impossible). Another difficulty is that the bandwidth probably would be extremely narrow and that we have no way of guessing the exact frequency used.

The contacting signals form a fascinating problem. Provided they do exist, they are intended to attract the attention of any new civilization. If we were able to guess the most economical method of doing this, we would know exactly what to look for; this would greatly increase the probability of detection and thus (to close the circle) would make this method the most economical. There is just one problem: how to define precisely the word *economical*? I have to admit that I have not found a definition worth writing down, and I must, at present, leave this problem open.

Suppose we had found the right definition. This would enable us to calculate for each method suggested the price C (or whatever we call measure of the effort on our side, on the other side, or on both) which has to be paid in order to yield a probability of

detection P_s over a distance D_s within a time t_s. For P_s we might take ½; for D_s, the average distance D (200 to 300 parsec); and for t_s, half of the number of years after which most new civilizations would consider giving up their search if it had not been successful (some hundred years, perhaps). We calculate the value of C for all methods suggested and conclude that the one with the lowest value of C will be exactly *the* method used by the others, with one condition. The methods we can think of, as well as our definition of *economy*, depend on our present state of advancement. The other civilizations will be much more advanced than we are but will have had experience with beginners, and they will have set a certain standard of what a beginner should know and how much he should be able to guess in order to be considered a future partner. The condition, then, is that we already meet this standard. But whether we do or do not, we shall find out only if we try.

The value of C should be lowest when all power is sent in a single narrow channel at a certain frequency which can be guessed by the listener. As Cocconi and Morrison pointed out (*7*), the only "milestone" we know of in the interesting range of frequencies which might be used for this purpose is the 21-centimeter line. I suggest a modification. The background of a signal would be much stronger within this line than beside it—so strong as to drown out a small signal—and the boundaries of the line are not well enough defined for us to place the signal exactly beside it. The next suggestion, then, might be to use, for example, exactly *twice* the frequency of the 21-centimeter line. If this should fail we would have to look for more sophisticated methods of producing contacting signals.

Each method will consist of a general *plan* for distributing the transmitted power over space, time, and frequency and of a number of *parameters* governing these distributions. We should be able to guess this plan, and to evaluate those parameters which minimize the value of C. As for the parameters which do not influence C, we will just have to try them out until we hit the right values. Thus, the probability of detection has to be calculated under the assumption that the plan and the minimizing parameters are known on our side and that we vary the remaining noncritical parameters systematically over their possible range. These, then, are the rules of this fascinating game.

We should mention two more rules which possibly could play a role. First, because of the long waiting times, the contacting signals would probably contain messages. There are two possibilities: either the whole contacting signal would vary in the manner of a coded message, or its plan would be devised in such a way that it would direct our attention to the exact frequency where the messages were being sent. Because detection has higher priority than the message and detection is easier if no irregularity (code) is involved, and because there would be no requirement for haste, in "speaking," I think that the second case is the more likely, and that a few channels would be enough for the message. Second, the contacting signal should not interfere with other activities, such as already existing communication: this means, for example, that it should not occupy too much of the whole frequency spectrum. (Contacting signals and long-distance calls would have about the same range of most economical frequencies.) To give an idea of the way in which the contacting signal might direct attention to the message, I shall give one example. We distribute a large number of signals over the economical frequency range in a pattern which is symmetrical with respect to the center of this range. Toward this center we decrease the spacing between the signals (and their bandwidth) in proportion to the distance from the center, until we arrive at an extremely narrow channel at the very center of the pattern (all other details of the arrangement are defined entirely by minimizing C). In this center channel an introduction to the language is repeated every 10 years, say, and at the end of this time the listener is told at which frequency to find the next message, and so on, all of these messages being sent simultaneously but being read in the right order. Finally, the listener is told at what frequency and with what power he should answer.

Third Conclusions

1) Our search should be guided by the assumption that the nature of the signals will be defined entirely by the purpose they serve and by the most economical way to achieve this purpose. We should try to guess both, in order to increase the probability of detection.

2) We have considered three kinds of signals, with different purposes, which we called local broadcast, long-distance calls, and contacting signals. The local broadcast has the highest likelihood of existing but would be extremely difficult to detect. Long-distance calls would exist in case *B* only, and the probability of their hitting us by chance is very small. Contacting signals would exist in case *B* only, and these have the highest probability of detection because they would be devised for that very purpose. For this reason and because of conclusion No. 4 of my "second conclusions," I recommend that we begin the search under the assumption of case *B* and look for contacting signals. If this should fail, we might then increase our effort by searching, under the assumption of case *A*, for local broadcasts.

3) At present, no definite program can be given for the search for contacting signals. But the general reasoning required to arrive at such a program is given: to guess and estimate as much as we can about the nature of the signals and to assume that the sender knows how much we can guess, because this approach leads to the most economical kind of contacting signals.

4) The search for other civilizations will have either a tremendous result or none at all. Thus I recommend, hoping that the first case obtains, that we begin as soon as possible and try as hard as we can. But to be prepared for the second case, I recommend the design of a receiving system which can be used for ordinary astronomy as well, since, because of the size and sensitivity needed for its prime task, it will be extremely powerful. The observing time should then be allocated in equal parts between the two projects assigned to the instrument.

References and Notes

1. It is a pleasure to thank F. D. Drake for many stimulating and helpful discussions and for reading the manuscript.
2. One parsec = 3.26 light-years = 3.086×10^{18} cm = 1.92×10^{13} mi.
3. The importance of this quantity and its connection with the distance was first pointed out by R. N. Bracewell [*Nature* **186**, 670 (1960)].
4. S. S. Huang, *Publs. Astron. Soc. Pacific* **71**, 421 (1959).
5. F. D. Drake, *Sky and Telescope* **19**, 140 (1959).
6. ———, in preparation.
7. G. Cocconi and P. Morrison, *Nature* **184**, 844 (1959).

Denver: 128th Annual Meeting

The guests at Denver's hotels, Horace Greeley wrote, had a "careless way, when drunk, of firing revolvers, sometimes at each other." There's no longer any shooting in the Brown Palace bar, and physicists are much thicker in Colorado than sourdoughs and cowmen. The mining West of false fronts and plank sidewalks has been replaced by prize-winning architecture and mountain-top laboratories where astrophysicists seek the origin of cosmic rays and study the effect of the sun upon the earth's weather.

There's some suggestion that the Wild West became especially wild for Greeley's benefit. At any rate, the local folk managed to gull the distinguished Eastern editor with a hoax that brought new thousands to rocky fields where pots of gold were nonexistent, and even pots of beans were scarce. The prospectors used a shotgun to salt a sandbar in Gregory Gulch with gold for Greeley. Greeley obligingly turned over the sand to discover the gold and wrote of his experience in tones of wonder that not only came out as an "exclusive" in the Rocky Mountain News (which printed on brown wrapping paper), but also made headlines around the world.

If you want to see that rococo monument of the silver bonanza, the Tabor Grand Opera House, you will find it on 16th St. The stage where Sarah Bernhardt and Edwin Booth walked is now used for Spanish-language movies. The cherrywood from Japan and carved Honduran mahogany which H. A. W. Tabor put into his flourish of civic pride has long since been stripped away, and the great chandelier lies covered with dust in the basement. Tabor, who rose from small storekeeper to appear on the floor of the U.S. Senate in a blaze of diamond studs, is one of the big figures of the Denver legend. Although he died penniless after the silver panic of 1893, he never lost faith in the Leadville mines where he had made his strike. "Hold onto the Matchless," he told his beautiful young wife, Baby Doe. And she did, until they found her, frozen, in an unheated shack near the mouth of the Matchless mine in 1935.

The splendid Brown Palace Hotel and the gold-leaf dome of the State Capitol are other reminders of the giddy era when it was sourdough today and champagne tomorrow, when rosewood pianos rode the narrow-gauge railways, pure gold frames hung on the barroom walls, and the lucky ones stopped at Delmonico's for beaver tail soup and Baltimore oysters after their trip to Denver's private mint. But the majority tired of washing dirt for a take of a few dollars a day and traded their claims for a plough.

A much older segment of Colorado's past is part of its scientific present at Mesa Verde, where archeologists are using radio beams to map their digging sites. The diggers hope eventually to unearth an explanation of why an industrious early society of squash planters and pottery makers abandoned the cliff dwellings they carved out of the mesa tops. At the annual meeting, these researchers will tell about the work in progress.

The Mesa Verde cliff dwellers told time by the sun, and astronomical observations remained the basis for measuring the passage of time through the busy centuries that followed. But now in the National Bureau of Standards

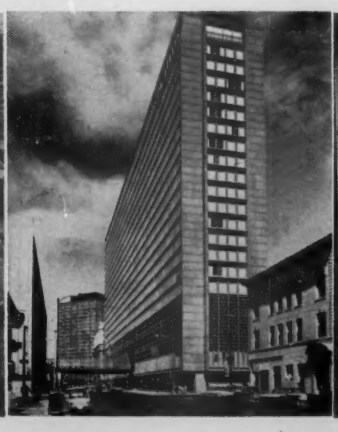
Fred Maroon photograph reproduced by permission of Holiday, copyright 1961, Curtis Publishing Co. Denver in 1866, by A. E. Mathews, courtesy of the Library of Congress.

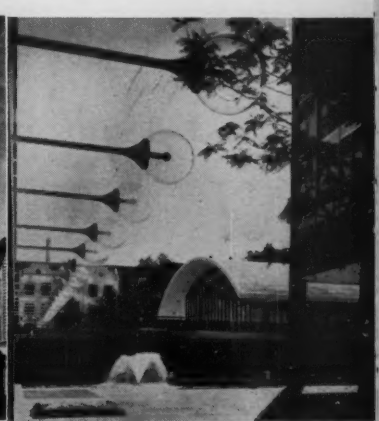
laboratory at Boulder the flow of atoms in a cesium beam provides a new time standard. Clocks timed by astronomical observations lose a second every 300 years, and while this has been adequate for such terrestrial affairs as war and gold mining, it is not accurate enough for space exploration. When the Bureau concludes its work on the new time unit about 1966, the standard second now in use may go the way of the sun dial.

If you'd like to know more about the Bureau's atomic clock and how it provides a time standard now used by many sorts of laboratories in the U.S., be sure to attend the symposium on physics research in the Rocky Mountain area on Wednesday. Here John M. Richardson of the Bureau's Boulder laboratory will bring us up to date on atomic definition of time. The West's present scientific wealth will be abundantly represented at this symposium; we have space to mention only a few examples: Los Alamos scientists will report on a method for detecting nuclear explosions in space; a Martin Co. scientist will review this company's work in solid state research; a physicist from the University of Wyoming will report on recent physical explorations of certain areas in biochemistry.

Colorado's glittering past and its unsurpassed natural wonders make the annual meeting even more of a holiday than usual. So don't forget your skis, and bring the whole family. While you are exploring the over-300 sessions of the program outlined in summary form on the following pages, the young people can enjoy the museums, ski slopes and other sights also listed.

Denver looked like this before the Gold Rush. Now city boasts buildings by architect I. M. Pei, Hilton Hotel and Mile High Center (right), which won the American Institute of Architects' award of merit for design excellence.





What To Do and See in Denver

By Essie White Cohn, Department of Chemistry, University of Denver

Museums

Colorado Museum of Natural History. City Park, near 18th and Colorado Boulevard. Accessible by Number 40 bus.

Excellent original exhibits, including particularly fine South American animal displays. Dramatic display effects achieved by modern mounting techniques. Ecological Hall shows local animal and plant life. Audio tour. Small planetarium. On a clear day, lounge offers view across City Park to the front range of the Rockies, including 14,264-foot Mt. Evans.

Schleier Art Gallery. 1343 Acoma Street. About two blocks from the Denver Hilton Hotel.

European and modern paintings, furniture and statuary of Western origin, display of early American home furnishings.

Oriental Art Museum. 14th and Bannock Streets. Adjacent to Schleier Art Gallery.

Small museum with high-quality selection.

Chapelle House. 1300 Logan Street.

Indian artifacts of high quality.

State Historical Society. 14th and Sherman Streets. Across from State Capitol.

Good collection of early-day Colorado items.

Universities and Laboratories

University of Denver. Science departments located on South Denver campus at South University and East Evans Avenue.

In addition to academic departments, houses Denver Research Institute. Strong divisions in electronics, metallurgy, mechanics, chemistry, and physics.

Regis College. West 50th Avenue and Lowell Boulevard.

Principal scientific interest is seismography.

Colorado School of Mines. Golden, 15 miles west of Denver.

Noted training center for the mining industry. Fine mineral exhibits. Research institute particularly interested in processes for separating complex ores.

University of Colorado. Boulder, 35 miles northwest of Denver.

Excellent campus, beautiful architecture, interesting departmental exhibits and collections. Also site of the offices of the High Altitude Observatory.

The University of Colorado School of Medicine is in Denver at 4200 East 9th Avenue.

Colorado State University. Fort Collins, 65 miles north of Denver.

Special interest in agriculture; specialized studies in hydraulics.

U.S. Air Force Academy. Five miles north of Colorado Springs.

Colorado College. Colorado Springs.

Excellent liberal arts college.

National Jewish Hospital. East Colfax Avenue at Colorado Boulevard, Denver.

Noted particularly for its research in the field of tuberculosis.

Denver and Rio Grande Western Railroad Company. General Office: 1531 Stout Street, Denver.

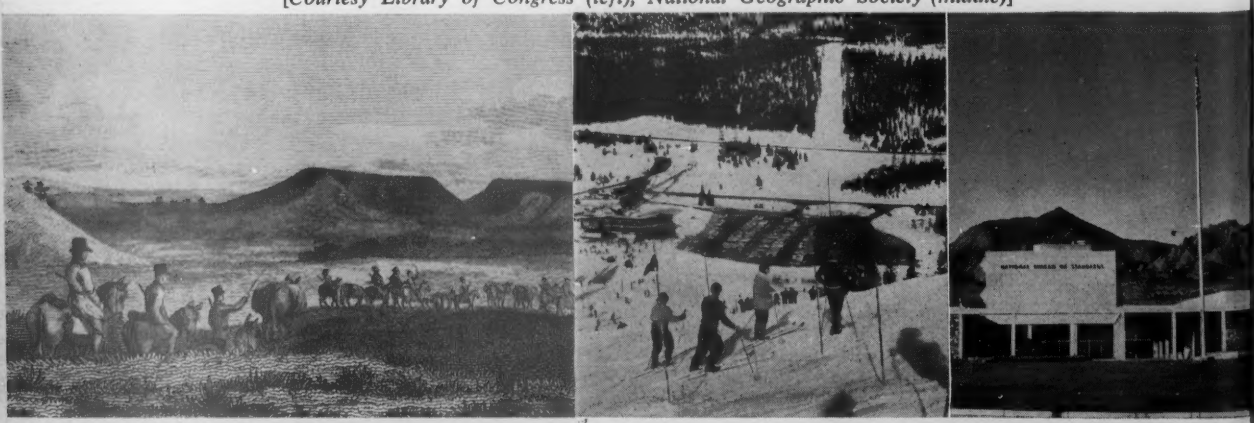
High-quality small laboratory responsible for many innovations in railroading. Especially interested in electron microscopy of oils, photoelastic studies in stress, and developments in nuclear energy applied to transportation.

Coors Porcelain Company. Golden, 15 miles west of Denver.

Manufacturers of chemical porcelain ware and porcelain specialties for defense industries.

Major Stephen Long and his 20-man expedition, shown here in old engraving, were among the first Americans to see the snowy Rockies, now full of skiers. Ski slope below at Berthoud Pass is 57 miles from Denver. Aspen's 40 miles of trails are 210 miles west of Denver. National Bureau of Standards Laboratory at Boulder will hold open house during week of meeting.

[*Courtesy Library of Congress (left); National Geographic Society (middle)*]



William Ainsworth and Sons, Inc. 2151 Lawrence Street, Denver.

Manufacturers of high-precision balances. Late developments include electronic recording micro-balances.

Martin Company, Denver Division. 12250 South Highway, Littleton, south of Denver.

Missile production (including Titan ICBM). Research units at the site and also at Cambridge Building, 4301 East Exposition Avenue, Denver.

Stanley Aviation Company. 2501 Dallas, Denver.

Manufacturers of aviation specialties.

Sundstrand Corporation, Denver Division. 2480 West 70th Avenue.

Manufacturers of aviation specialties.

U.S. Bureau of Reclamation. 10 miles west of Denver.

Hydraulics laboratories and concrete testing laboratories are of special interest.

U.S. Bureau of Standards Laboratories. Boulder.

Consists of three sections: (i) general electronics, (ii) microwaves, (iii) cryogenics.

High Altitude Observatory. Offices in Boulder. Laboratory at Climax, Colorado, about 125 miles from Denver by mountain highways. May not be accessible in December.

This nationally known institution has been primarily interested in coronagraph studies but is expanding into the field of general meteorology.

Inter-University High Altitude Laboratory. Offices, University of Denver; laboratories, Echo Lake and Mt. Evans. Mt. Evans laboratory inaccessible in December, and Echo Lake laboratory (65 miles from Denver by mountain road) may not be accessible in December.

Well known for studies in cosmic rays and is becoming known as a center for high-altitude studies in biology.

Public Buildings

Colorado State Capitol. Overlooking Civic Center from the east. Dome covered with gold leaf from Colorado mines.

United States Mint. West Colfax at Cherokee. Stores more gold bullion ($6 billion worth) than any other U.S. depository except Fort Knox. Tours by special arrangement.

Theater of the Red Rocks. Red Rocks Park, off Hogback Road. An amphitheater carved from tower red cliffs.

Restaurants

Palace Arms, Brown Palace Hotel. One of this country's great restaurants.

Navarre. 1727 Tremont. Atmosphere and fine food.

La Fitte. 14th at Larimer. Seafood; elegant New Orleans decor.

Quorum. 233 East Colfax. Opposite State Capitol. Fine French cuisine.

Gold Hunters' Guide

The pictographs identified below are intended to guide you through the day-by-day summary of the annual meeting which follows.

- AAAS as a whole
- Agriculture
- Anthropology
- Astronomy
- Biological sciences
- Botanical sciences
- Chemistry
- Dentistry
- Education
- Geology, geography
- History, philosophy of science
- Industrial science
- Mathematics
- Medical sciences
- Pharmacy
- Physics
- Psychology
- Social and economic sciences
- Space science
- Sci Teach — Science in general
- Zoological sciences
- Lunch
- Dinner
- Cocktails
- Reception or mixer

Tuesday

26 December 1961

Survival Symp. Comm Sci Human Welfare

Econ of Information, Am Econ A

Empiricism and Status of Theories I

Moving Frontiers of Science I, AAAS

Ground Water Geology I Symp

Geography I, Papers AAG

Papers

Joint session with CEC

Prediction and Causality II

Wednesday
27 December 1961

Thursday
28 December 1961

Arctic-Alpine Vegetation Symp I, ESA

Space Biochem Biology Symp I

Monosaccharides, Symp

AAG Geography Papers II

Geology Papers

Rocky Mt Physics Symposium I

AAS Concurrent Papers

AAS Papers

Teacher Education AAAS Comm NARST

Session with CEC, II

Oral Aspects of Genetics Symposium I

Land and Water Use Symposium I

General Ecology, ESA Papers

Animal Ecology, ESA Papers

Hospital Pharmacy, Papers I

Plant Biology Symp I

PS Papers I

History, Philosophy of Science, III

Sci Teach — Molecular Biology Symposium

Physics of the Upper Atmosphere Symp

Water and Climate Symp

Geochemical Evolution I

Radioactivity in Man

Neurosecretion Symp I, ASZ

Animal Behavior I ASZ, ESA Papers

Histol Cytogenet, Papers ASZ

Demonstrations ASZ, Papers III

Classification, Data, Symp II, SSZ

Sci Teach — Outdoor Nature Interpretation, ANS

Accent on Investigating II, NABT

Science Facilities II, NSTA

Biomet WNAR Papers

Induction VP Address

Concept of Race Symp

Geography IV Papers AAG

Opportunities in Health Professions AED

Genetics, Evolution, Human Behavior I, PA

ASN President's Address

Sci Teach — Presidential Address, NABT

VP Address, Award

Sci Teach — NABT Address

Address (12:30)

VP Address

AED Address (12:15)

Friday
29 December 1961

Saturday
30 December 1961

Arctic-Alpine Mammals Symp, ESA

Arctic-Alpine Vege, ESA Symp III

AS Address

Teaching Machines, Math Symp, AAAS Comm

Neurosecretion Symp III, ASZ

Vertebrate Locomotion Symp, ASZ

Animal Behavior III, ASZ, ESA Papers

Develop Biology I, ASZ Papers

PS Papers II

Biogeography of Philippines, Symp I, SSZ

Human Genetics I

Machines and Brains VI

Teaching Systems Thinking Symp, SGSR

Manned Lunar Flight AS Symp I

Civilizations in Desert Land, Symp

Geochemical Evolution Symposium II

Rural Crime Control I, Criminol

Sociology of Medicine, Sociol Symp

Management Science Symp, IMS

Papers

Land and Water Use IV

VP Address, Papers I

Sci Teach — Biology Films, NABT

Space Science Vista III NSTA

Speleogenesis, NSS

Aspects of Sleep, Symp

Water Improvement Symp I, Comm Arid Zones

AAS Papers

AAS Concurrent Papers

Criminol Research IV, Criminol

Government Price Statistics, Am Stat

Interdepend Archeol and Ethnol Symp

Appetite Behavior Symp

Nature of Historical Explanation VIII

Human Genetics Symp III

AAAS Council Meeting II

Preteaching Students Symp, AERA

Papers

Cellular Endocrinology Symp, ASZ

Comp Physiology II Papers, ASZ

Dev Biology II Papers, ASZ

PS Papers

Sci Teach — Rocky Mountains, Natural History, ANSS

Accent on Investigating IV, NABT

Science Curricula IV, NSTA

Applied Anthropology

AAS Papers

Papers

SSZ Papers

RESA ANNUAL CONVENTION

Goals of Psychotherapy Symp I (10:45)

Address

AAAS Section Officers

AS Address

SIGMA XI PROCTER PRIZE, RESA ADDRESS

AAS Society Photograph

Conf Scientific Communica (12:30)

Colo STA Address

Wednesday PM

27 December 1961

BBB Address

VP Address

Arctic-Alpine Environment, ESA Symp

Social-Behavorial Research Problems

Information Processing, BIO Papers

Hospital Pharmacy, Symp II, Papers

Ground Water Geology, Symp II

Land, Water Use, Symp II

Sci Teach — Elementary Science, All Societies

Collegiate Academies, AC Debate

Oral Aspects of Genetics II, Symp

Space Biochem, Biology, Symp II

Biochem Phyletic PS Symp

Polysaccharides, Symp

Data Classification, Symp I, SSZ

Genetics, Evolution, Human Behavior II, PA

VP Address

Conventionalism and Laws in Mod Physics

Geography III, AAG Papers

Physics of Rocky Mt Area, Symp II (2:30)

Sci Teach — Nature Study around World, ANSS

Earth Science, Symp I, NSTA

Plant Biology Today, Symp II (2:30)

Accent on Investigating I, NABT (All 2:30)

AAS Papers
AAS Concurrent Papers

Sci Teach — Elementary Science, AAAS Coop Comm

AAAS Council I

ACS

Conf Sci Manpower, Address

Sci Teach

NASW

Geologists'
AAG Geographers'

AC
NASW Awards

VP Address

Glenn Seaborg: 29th John Wesley Powell Lecture (8:30)

Helen B. Warner Lecture, AAS

Intern Relations

Papers

Thursday PM

28 December 1961

AAAS George Sarton Memorial Lecture

Arctic-Alpine Vegetation, Symp II, ESA

AAAS Moving Frontiers of Science II

AC Junior Science

Neurosecretion Symp II, ASZ

Sci Teach — International Resource Development Symp, ANSS, NABT

Animal Behavior II, ASZ, ESA Papers

Accent on Investigati III, NABT

Invert Zoology, ASZ Papers

AS Tour, Martin Co

ASZ Demonstrations

Classification Data, Symp III, SSZ

Arctic-Alpine Invertebrates, Birds, ESA Sy

Biomet, WNAR Pape

Man and the Computer ACM Papers

Plant Ecology, ESA Papers (2:30)

Demonstrations, Films, AAS (3:30)

SSZ, Systematists, Coffee (4:30)

WOMEN IN SCIENCE, TEA, SDE (4:30)

AAS

AS Registration

AAAS Presidential Address
AAAS Presidential Reception (9:15)

Friday PM

29 December 1961

Land and Water Use Symp V

Human Genetics Symp II

Early Man in Western U.S., Symp

Wetherill Mesa Project, Symp

Vert Morphology, ASZ Papers

Arthropod Physiol, ASZ Papers

Reproductive Behavior, ASZ, ESA

Biogeography of Philippines Symp II, SSZ

Prob in Contemporary Penology, Criminology

Amer Highway Operation Symp, Am Stat

Manned Lunar Flight II, Physiol

Shaping of a Scientist, Symp

Goals of Psychotherapy Symp II

Biology and Math Symp, SIAM (2:30)

Sci Teach

NARST Research Symp

Extracurricular Motivation for Science, Sci Serv

NABT, Films

Catholic H.S. and the BSCS, NABT

Methodological Problems VII

Law, Science and Decision-Making, Phil of Sci

Organic and Biochem Papers

Analytical and Phys Papers

Magnetic Fields in Solar System Symp, AAS

NSS General Session

AS Manned Lunar Flight III (4:15)

Appetite Behavior Papers II (4:30)

Zoologists' VP Address, ANSS

AS Film

(7:30)

gma Xi, Phi Beta K Address
au Beta Pi Address (9:15)

Criminol Awards Memorial Meeting

Saturday PM

30 December 1961

Recomm Training Math Teachers, CUPM

Human Genetics Symp IV

Animals in Human Ecology

Incest in Cross-Species Perspective

VP Address

Conf Sci Commun Inaug New Section

Water Improvement Symp II

Comp Endocrinology, ASZ, Papers

Comp Physiol III, ASZ, Papers

Dev Biology III, ASZ, Papers

Control of Verbal Behavior, Symp

Technol in Educa Symp, AERA

Papers

Museum School Service, ANSS, NABT

Twentieth Century Policing V, Criminol

AAG: Association of American Geographers
AAS: American Astronomical Society
AC: Academy Conference
ACM: Association for Computing Machinery
ACS: American Chemical Society
AED: Alpha Epsilon Delta—National Premedical Honor Society
AERA: American Education Research Association
ANSS: American Nature Study Society
APSA: American Political Science Association
AS: American Astronautical Society
ASN: American Society of Naturalists
ASZ: American Society of Zoologists
BBB: Beta Beta Beta Biological Society
BIO: Biomedical Information-Processing Organization
BSCS: Biological Sciences Curriculum Study
CEC: Council for Exceptional Children
CUPM: Committee on Undergraduate Program in Mathematics
ESA: Ecological Society of America
IMS: Institute of Management Sciences
NABT: National Association of Biology Teachers
NARST: National Association for Research in Science Teaching
NASW: National Association of Science Writers
NSTA: National Science Teachers Association
NSS: National Speleological Society
PA: American Psychiatric Association
PS: Society of Protozoologists
RESA: Scientific Reseach Society of America
SDE: Sigma Delta Epsilon
SGSR: Society for General Systems Research
SIAM: Society for Industrial and Applied Mathematics
SSZ: Society for Systematic Zoology
SWRM: Southwestern - Rocky Mountain Division
VP: Vice Presidential

Lecture, Film
Natl Geog Society

AAAS Special Sessions

One of the characteristic and most important features of the annual meetings of the Association is the series of outstanding general addresses by distinguished authorities, sponsored by the Association or by organizations that meet regularly with it. These special events are open to the general public of the city in which the meeting is held.

Moving Frontiers of Science. Part I, 26 Dec., evening. "Changing concepts of mineral raw materials in the national economy," Howard A. Meyerhoff, executive director, Scientific Manpower Commission; "The molecular designing of materials," Arthur R. von Hippel, director, Laboratory for Insulation Research, Massachusetts Institute of Technology. William W. Rubey, member, AAAS board of directors, will preside.

John Wesley Powell Lecture (of the Southwestern and Rocky Mountain Division). 27 Dec., evening. "Minds, men, and materials: a scientific appraisal," Glenn T. Seaborg, chairman, U.S. Atomic Energy Commission. Paul M. Gross, AAAS president elect, will preside.

George Sarton Memorial Lecture. 28 Dec., afternoon. "The International Geophysical Year," Joseph Kaplan, head, department of physics, University of California, Los Angeles. Chauncey D. Leake, AAAS retiring president, will preside.

Moving Frontiers of Science. Part II, 28 Dec., afternoon (after the Sarton lecture). "Evolution of stars and galaxies," Halton C. Arp, Mount Wilson and Palomar Observatories; "Energy flow in ecological systems," E. W. Fager, Scripps Institution of Oceanography. Harrison Brown, member, AAAS board of directors, will preside.

AAAS Presidential Address. 28 Dec., evening. "The status of pharmacology as a science," by Chauncey D. Leake, retiring president of the AAAS. Thomas Park, AAAS president, will preside. Preceding the address, Robert L. Stearns, general chairman of the Denver meeting, will speak briefly, and AAAS awards will be presented. Guests of honor will include Frank E. E. Germann, past president and former secretary of the AAAS Southwestern and Rocky Mountain Division; J. L. Still, treasurer, Australian-New Zealand Association for the Advancement of Science; and Roland Harper, member, British Association for the Advancement of Science, and the department of psychology, University of Leeds (England).

After the address there will be an informal AAAS presidential reception in the adjacent foyer and ballroom areas. Simple refreshments will be served; in addition, nearby there will be a "Dutch treat" bar. All registrants and members of the local committees are cordially invited to attend.

Joint annual address of the Society of the Sigma Xi and the United Chapters of Phi Beta Kappa. 29 Dec., evening. "Science and government," Harrison Brown, professor of geochemistry, California Institute of Technology. William W. Rubey will preside.

Annual address of the Tau Beta Pi Association. 29 Dec., evening. "The second engineering revolution," John A. Logan, chairman, department of civil engineering, Northwestern University. George G. Lamb, member, executive council, Tau Beta Pi, and professor of chemical engineering, Northwestern University, will introduce the speaker. Paul A. Scherer, AAAS treasurer, will preside. (Follows Phi Beta Kappa address.)

Annual lecture and film of the National Geographic Society. 30 Dec., evening. "The sacred well of Chichén Itzá," Matthew W. Stirling, research associate, Smithsonian Institution, and member of the National Geographic Society's committee for research and exploration. Margaret Mead, member, AAAS board of directors, will preside.

AAAS General Sessions

The general sessions are broad interdisciplinary programs, sponsored by the Association as a whole, by AAAS sections, by AAAS committees, or by AAAS affiliates; they are given here in chronological sequence.

Committee on Science in the Promotion of Human Welfare. 26 Dec., afternoon. Symposium, "Problems of Survival." Barry Commoner, chairman, AAAS Committee on Science in the Promotion of Human Welfare, will preside and give introductory remarks. "Anticipated biological and environmental effects of detonating a large megaton weapon on an American metropolis," Tom T. Stonier, Rockefeller Institute. "Industrial organization and disorganization in nuclear war," Seymour Melman, Columbia University. "Technical problems of survival and recuperation in a radiological environment," Walter E. Strope, U.S. Department of Defense. "Social consequences of focus on survival," Margaret Mead, American Museum of Natural History. After the papers there will be discussion. Members of the committee which planned this program are: Barry Commoner, Washington University, chairman; Robert B. Brode, University of California, Berkeley; T. C. Byerly, U.S. Agricultural Research Service; Lawrence K. Frank, Belmont, Mass.; H. Jack Geiger, Harvard Medical School; Frank W. Notestein, Population Council, New York; Walter Orr Roberts, University Corporation for Atmospheric Research, Boulder, Colo.; Margaret Mead, American Museum of Natural History, ex officio board representative; and Dael Wolfle, AAAS (ex officio).

Interdisciplinary Symposium in the Physical Sciences. Physics of the Upper Atmosphere. 28 Dec., morning. Joint program of the AAAS Sections on Physics and Astronomy, cosponsored by the American Astronomical Society, the American Geophysical Union, the American Meteorological Society, and Sigma Pi Sigma. Arranged by Stanley S. Ballard, University of Florida, and Alan H. Shapley, National Bureau of Standards, Boulder, Colo. Alan H. Shapley will preside. "The atmosphere above 50 kilometers," William G. Stroud, Goddard Space Flight Center, Greenbelt, Md. "Atmospheric winds and diffusion coefficients in the 100-kilometer region," Edward Manring, Geophysics Corporation of America, Bedford, Mass. "The invisible aurora," Franklin E. Roach, National Bureau of Standards, Boulder, Colo. "Scatter sounding of the high atmosphere," Von R. Eshleman, Stanford University.

Interdisciplinary Symposium in the Earth Sciences. Geochemical Evolution —The First Five Billion Years. Part I: Cosmic and Geological Aspects. 28 Dec., morning. Program of the AAAS Section on Chemistry, cosponsored by the AAAS Sections on Geology and Geography, Zoological Sciences, and Botanical Sciences, the American Geophysical Union, and the Geological Society of America; and with the assistance of the American Chemical Society, Colorado section, and the Colorado-Wyoming Academy of Science. Arranged by T. S. Lovering, U.S. Geological Survey, Denver, Colo., who will preside. "The origin of the chemical elements," G. R. Burbidge, Yerkes Observatory, University of Chicago. "The origin of the atmosphere of the plan-

ets," Harold C. Urey, University of California, La Jolla. "The role of the primitive environment in shaping the course of the origin of life," Philip H. Abelson, Geophysical Laboratory, Carnegie Institution of Washington, Washington, D.C. "The geochemical evolution of continental crusts," Albert E. J. Engel, University of California, La Jolla.

Interdisciplinary Symposium in the Biological-Medical Sciences. Existing Levels of Radioactivity in Man and His Environment: Measurement and Significance. 28 Dec., morning. Joint program of the AAAS Sections on Pharmacy, Zoological Sciences, Botanical Sciences, Medical Sciences, Dentistry, Agriculture, and Education. Arranged by John E. Christian, Purdue University, who will preside and give introductory remarks and radioisotope demonstrations. "Radioactivity levels in man and his environment—contribution and potential hazards of reactor and isotope powered space vehicles," Wright H. Langham, Los Alamos Scientific Laboratory. "Existing levels of cosmic-ray produced radioactivity—present and potential applications to archeology, meteorology, geochronology, and oceanography," James A. Arnold, University of California, San Diego. "Measurements of the existing radioactivity of people and foods. Applications to nondestructive measurements of body composition (potassium, lean, fat, water), medical diagnosis, age studies, and fall-out studies," Ernest C. Anderson, Los Alamos Scientific Laboratory. "The relationship of existing radiation levels to carcinogenesis," P. R. J. Burch, University of Leeds (England).

Interdisciplinary Symposium in the Social Sciences. Water and Climate. 28 Dec., morning. Joint program of the AAAS Section on Agriculture and the Committee on Desert and Arid Zones Research of the AAAS Southwestern and Rocky Mountain Division, cosponsored by the Sections on Geology and Geography, Social and Economic Sciences, Engineering, and Industrial Science, the American Geophysical Union, and the American Meteorological Society. Arranged by Terah L. Smiley, University of Arizona, and D. Wynne Thorne, Utah State University. Terah Smiley will preside. "A meteorologist looks at hydroclimatology," Paul R. Julian, High Altitude Observatory, University of Colorado. "Capture of additional water for increasing supplies," John W. Harshbarger, University of Arizona. "Weather modification," Earl G. Droessler, National Science Foundation. "Legal aspects of a national water policy," Morris K. Udall, House of Representatives, U.S. Congress.

Interdisciplinary Symposium in the Earth Sciences. Geochemical Evolution—The First Five Billion Years, Part II: Minor Elements in the Biosphere and in Surface Waters. 29 Dec., morning. (Same sponsor, cosponsor, and arranger as for part I.) Essie White Cohn, University of Denver, will preside. "Effects of some minor elements on animals and people," William H. Strain, Strong Memorial Hospital, Rochester, N.Y. "Biochemical cycle of some minor elements in plants," Perry R. Stout, University of California, Davis. "Biochemical cycle of vanadium in plants," Helen Cannon, U.S. Geological Survey, Denver. "Implications of the minor element content of some major streams of the world," Walton Durum, U.S. Geological Survey, Washington, D.C., and Joseph Haffty, U.S. Geological Survey, Denver, Colo. "Minor elements in some major municipal water supplies in the United States," Charles Durfor, U.S. Geological Survey, Washington, D.C. T. S. Lovering and Essie White Cohn will give a commentary on the symposium.

Symposium: Teaching Machines and Mathematics Programs. The Interaction of Content and Programing Specialists in Developing Self-instructional Programs. 29 Dec. morning. Joint program of the AAAS Cooperative Committee on the Teaching of Science and Mathematics and the AAAS Sections on Mathematics and Psychology. Arranged by Joseph Hammock, Bell Telephone Laboratories, Murray Hill, N.J., and John R. Mayor, AAAS. Joseph Hammock will preside. Speakers will be Lewis D. Eigen, Center for Programed Instruction, New York, N.Y.; John A. Barlow, Emory University; Norman A. Crowder, Educational Sciences Division, U.S. Industries, Inc., New York, N.Y.; Lloyd E. Homme, Teaching Machines, Inc., Albuquerque, N.M.; Jack E. Forbes, Britannica Center for Studies in Learning and Motivation, Palo Alto, Calif. Discussants will be Max Beberman, University of Illinois; R. Creighton Buck, University of Wisconsin; Robert M. Gagné, Princeton University.

Symposium: Water Improvement. Part I. 30 Dec., morning. Program of the Committee on Desert and Arid Zones Research of the AAAS Southwestern and Rocky Mountain Division, cosponsored by the AAAS Section on Agriculture. Arranged by Joseph A. Schufle, New Mexico Institute of Mining and Technology, and Terah L. Smiley, University of Arizona. Terah L. Smiley will preside. "Contamination of underground water—vicinity of Denver," William N. Gahr, Colorado State Department of Public Health, Denver. "New dimensions in water pollution research," Gordon McCullum and Bernard B. Berger, U.S. Public Health Service, Washington, D.C. "The salt water intrusion problems in coastal aquifers," David K. Todd, University of California, Berkeley. "The zone of diffusion and its consequences," H. H. Cooper, U.S. Geological Survey, Tallahassee, Fla.

Part II. 30 Dec., afternoon. (Same sponsor, cosponsor, and arrangers as for part I.) John W. Harshbarger, University of Arizona, will preside. "Electrochemical demineralization of water—theory and practice," George W. Murphy, University of Oklahoma. "Operating characteristics of ground water reservoirs occupying a trench," Robert E. Glover and Morris M. Skinner, Colorado State University. Peter C. Duisberg, consultant, El Paso, Tex., and John F. Lance, University of Arizona, will give a summary.

AAAS Conferences

In addition to the Academy Conference, composed of official delegates from most of the 47 state and city academies of science affiliated with the AAAS, several conferences have become recurrent events at AAAS meetings. These conferences are open to all who are interested. Academy Conference, 27 and 28 Dec. Conference on Scientific Communication, 30 Dec. Conference on Scientific Manpower, 27 Dec.

Topical Index of Symposia

Details of the various programs listed can be found in this and earlier issues of *Science*. Issues and page numbers are given in parentheses.

AAAS General Symposia. Moving Frontiers of Science (8 Dec., p. 1852). Interdisciplinary symposium in the physical sciences: physics of the upper

atmosphere (8 Dec., p. 1852). Interdisciplinary symposium in the earth sciences: geochemical evolution—the first 5 billion years (8 Dec., p. 1852). Interdisciplinary symposium in the biological-medical sciences: existing levels of radioactivity in man and his environment (8 Dec., p. 1853). Interdisciplinary symposium in the social sciences: water and climate (8 Dec., p. 1853).

AAAS Committee on Science in the Promotion of Human Welfare. Problems of survival (8 Dec., p. 1852).

AAAS Cooperative Committee on the Teaching of Science and Mathematics. Teaching machines and mathematics programs (27 Oct., p. 1376). Studies in teacher education (1 Dec., p. 1761). Elementary school science (1 Dec., p. 1762).

AAAS Southwestern and Rocky Mountain Division. Committee on Desert and Arid Zones Research. Water improvement (10 Nov., pp. 1533, 1538).

Academy Conference. Why collegiate academies? (1 Dec., p. 1763). Junior academies (1 Dec., p. 1764).

Conference on Scientific Communication. Inauguration session for possible new section: Problems of communication (1 Dec., p. 1764).

Mathematics. Recommendations on the training of teachers of mathematics (27 Oct., p. 1378). Man and the computer (27 Oct., p. 1376). Biology and mathematics (27 Oct., p. 1376).

Physics. Physics research in the Rocky Mountain area (3 Nov., p. 1438).

Space Science. Manned lunar flight (3 Nov., p. 1438). Extraterrestrial biochemistry and biology (27 Oct., pp. 1375, 1376).

Chemistry. Recent advances in carbohydrates (27 Oct., p. 1376).

Astronomy. Magnetic fields in the solar system (3 Nov., p. 1440).

Geology and Geography. Ground water problems in the Rocky Mountains and Great Plains (10 Nov., p. 1534). Speleogenesis (10 Nov., p. 1537).

Zoological Sciences. Neurosecretion (17 Nov., p. 1630). Vertebrate locomotion (17 Nov., p. 1630). Evolutionary changes in the hormonal and neural bases of reproductive behavior (17 Nov., p. 1630). Cellular endocrinology (17 Nov., p. 1631). Biochemical phyletic markers among the protozoa (17 Nov., p. 1631). The data of classification (17 Nov., p. 1631). Biogeography of the Philippines (17 Nov., p. 1631).

Biological Sciences (see also Medical Sciences). Biology and mathematics (27 Oct., p. 1376). Invited papers of Biomedical Information-Processing Organization (17 Nov., p. 1632). Invited papers of Biometric Society, WNAR (17 Nov., p. 1632). North American Arctic-Alpine ecology (17 Nov., p. 1632). Molecular biology (1 Dec., p. 1762).

Botanical Sciences. Plant biology today (17 Nov., p. 1633).

Anthropology. Concept of race (24 Nov., p. 1700). Civilizations in desert lands (24 Nov., p. 1700). Early man in the western United States: cultural continuities (24 Nov., p. 1700). Wetherill Mesa project (24 Nov., p. 1700). Interdependence of archaeology and ethnology (24 Nov., p. 1702). Applied anthropology (24 Nov., p. 1700). Role of animals in human ecological adjustments (24 Nov., p. 1700). Incest in cross-species perspective (24 Nov., p. 1702).

Psychology. Aspects of sleep (24 Nov., p. 1702). Goals of psychotherapy (24 Nov., p. 1702). Sensory factors in appetitive behavior and food acceptance (24 Nov., p. 1704). Control of verbal behavior (24 Nov., p. 1704).

Social and Economic Sciences. Current problems in social-behavioral research (24 Nov., p. 1704). Economics of knowledge and information (24 Nov., p. 1704). International relations (24 Nov., p. 1704). Rural crime control (24 Nov., p. 1705). Problems in contemporary penology (24 Nov., p. 1705). Research and experimentation in criminology (24 Nov., p. 1705). Problems and controversies in twentieth century policing (24 Nov., p. 1706). Sociology of medicine: problems and prospects (24 Nov., p. 1706). Problems of the American highway operation (24 Nov., p. 1706). Government price statistics (24 Nov., p. 1706). Management science (24 Nov., p. 1706).

History and Philosophy of Science. (1 Dec., p. 1760). Empiricism and the status of theories. Prediction and causality. History and philosophy of science. Conventionalism and laws within modern physics. Induction. Machines and brains. Methodological problems of the social sciences. Nature of historical explanation. Law, science, and decision making. Teaching of systems thinking.

Medical Sciences. Physiological and biochemical aspects of human genetics (17 Nov., p. 1633). Career opportunities in the health professions (17 Nov., p. 1634). Genetics and evolution of human behavior (17 Nov., p. 1634).

Dentistry. Oral aspects of genetics (17 Nov., p. 1634).

Agriculture. Land and water use (10 Nov., pp. 1533, 1537, 1538).

Education. The shaping of a scientist (1 Dec., p. 1761). Intervention in personality development of college students preparing to teach (1 Dec., p. 1761). Technology in education (1 Dec., p. 1761). Teaching machines and mathematics programs (1 Dec., p. 1762). Studies in teacher education (1 Dec., p. 1761). Elementary school science (1 Dec., p. 1762). Extracurricular motivation for science (1 Dec., p. 1762).

Science Teaching. Molecular biology (1 Dec., p. 1762). Nature study around the world (1 Dec., p. 1762). Outdoor nature interpretation (1 Dec., p. 1762). Conservation and international resource development (1 Dec., p. 1763). Natural history of the Rocky Mountains (1 Dec., p. 1763). Museum school service and displays (1 Dec., p. 1763). Vistas in science (1 Dec., pp. 1762, 1763). Accent on investigating (1 Dec., p. 1763). Research symposium (1 Dec., p. 1763). The Catholic high school and the BSCS curriculum (1 Dec., p. 1763).

AAAS Science Theatre

The AAAS Science Theatre, a permanent feature of the Association's annual meeting, presents each year a selection of the latest domestic and foreign scientific films, throughout the meeting period. Programs are repeated at different times to increase the opportunities for those attending the sessions of the 128th meeting to see particular films. The Association is indebted to all those who made these pictures and lent them for showing, and indebted for their assistance to Malcolm S. Ferguson, National Institutes of Health; to Richard A. Boolootian, University of California, Los Angeles; and to the American Science Film Association (Robert E. Green, secretary), Washington, D.C.

The Science Theatre may be reached by passing through the Annual Exposition of Science and Industry, on level 2B, Convention Center, Hilton Hotel. Admission is restricted to those who wear the AAAS Convention Badge. (Children under 16 are not registered.)

27 December, 10 A.M. to 2 P.M.

Voice Production—The Vibrating Larynx. Produced by the University of Groningen, in collaboration with Stitchting Film en Wetenschap, Utrecht, Netherlands.

Epidemiology of Histoplasmosis. Produced by David S. Ruhe, Kansas University Medical Center.

Microcirculation Studies. Produced by the University of Michigan Audio-Visual Education Center.

Medical Genetics, Part 2. Produced by Victor McKusick, Johns Hopkins University, for the National Foundation.

Total Body Measurement of Natural and Acquired Radioactivity in Man. Produced by Department of the Army.

The Sea Otter. Produced by R. A. Boolootian, University of California, Los Angeles.

Looking into Space. Produced by Hans Elias, Chicago Medical School.

Frescan—AN/SPS-42. Produced by Hughes Aircraft Company.

Man in Flight. Produced by U.S. Air Force.

Hoolaulea—Traditional Dances of Hawaii. Produced by Honolulu Academy of Arts.

Water. Produced by Center for Mass Communication of Columbia University for the Visual Information Board of the United Nations.

Our Nearest Star: Radioisotope Power System for the Transit Satellite. Produced by Martin-Nuclear, Baltimore, Md.

27 December, 2 to 6 P.M.

Plague in Sylvatic Areas. Produced by Communicable Disease Center, Atlanta, Ga.

Gamma Globulin. Produced by Synergist Productions, Inc., for Merck, Sharp & Dohme.

Small Electric Currents in Intravascular Thrombosis. Produced by Roman Vishniac and Phillip N. Sawyer.

The Life Cycle of a Bacteriophage. Produced by Department of Bacteriology and University Extension, University of California, Davis.

Anaphylaxis in Guinea Pigs. Produced by Department of Bacteriology and University Extension, University of California, Davis.

The Complement Fixation Test. Produced by Department of Bacteriology and University Extension, University of California, Davis.

The Biology and Reproduction Behavior of the Northern Elephant Seal. Produced by George Bartholomew and Richard A. Boolootian, University of California, Los Angeles.

The Pond. Produced by Crawley Films Ltd. and Campbell Productions for International Film Bureau, Inc.

Social Behavior of Domesticated Norway Rats (Part 3: High Vitamin A Diet). Produced by J. B. Calhoun, National Institute of Mental Health.

Way to a New World. Produced by Australian News and Information Bureau.

Refining Precious Metals from the Sudbury Nickel Ores. Produced by Film Graphics, Inc.

The AETR (Advanced Epithermal Thorium Reactor). Produced by Atomics International, a division of North American Aviation, Inc., for Southwest Atomic Energy Associates.

The Flying Coronascope. Produced by High Altitude Observatory, Boulder.

28 December, 10 A.M. to 2 P.M.

Micromechanisms of Water-Oil Displacement. Produced by Jersey Production Research Company.

The Magic of Sulphur. Produced by Texas GulfSulphur Company.

Marine Snow—The Origin of Oil. Produced by Tokyo Cinema Company, Inc.

Short Term Visual Memory. Produced by Bell Telephone Laboratories, Inc.

The Mentally Ill: Organic Research. Produced by WCET-TV.

Vacant Lot. Produced by Crawley Films Ltd. and Campbell Productions for International Film Bureau, Inc.

Tissue Injury in Intravascular Thrombosis. Produced by Roman Vishniac and Phillip N. Sawyer.

The Real Story of Radar. Produced by the National Film Board of Canada.

MSG-4, Missile Monitor. Produced by Hughes Aircraft Company.

Operation Bluenose. Produced by Space and Information Systems Division of North American Aviation.

28 December, 2 to 6 P.M.

Same as 27 December, 10 A.M. to 2 P.M., except that *Looking into Space* will be presented first, at 2 P.M.; the other films will follow in the order given.

29 December, 10 A.M. to 2 P.M.

Same as 27 December, 2 to 6 P.M.

29 December, 2 to 6 P.M.

Same as 28 December, 10 A.M. to 2 P.M.

30 December, 9 A.M. to 1 P.M.

Microcalorimetrie et Thermogenèse. Produced by Professor Calvet, National Center for Scientific Research, Marseilles, France.

Culture and Association in vitro of Young Chicken Embryo Blastoderms. Produced by Professor Wolff, College of France, Nogent-sur-Marne, and by Service du Film de Recherche Scientifique.

Hylotrupes Bajulus (Cerambycidae)—Entwick-Lungszyklus. Produced by Institut für den Wissenshaftlichen Film für *Encyclopaedia Cinematographica.*

Cupiennius Salei—Kokonbau und Eiablage. Produced by Institut für den Wissenshaftlichen Film für *Encyclopaedia Cinematographica.*

Thaumetopoea or *La Chenille Processionnaire du Pin.*

La Crevette et Son Bopyre. Produced by Jean Painlevé.

Ancyclostoma: Life History of Hookworms. Produced by Sakura Motion Picture Company, Ltd.

Marine Snow—The Origin of Oil. Produced by Tokyo Cinema Company, Inc.

Hoolaulea—Traditional Dances of Hawaii. Produced by Honolulu Academy of Arts.

Medical Genetics, Part 2. Produced by Victor McKusick, Johns Hopkins University, for the National Foundation.

Voice Production—The Vibrating Larynx. Produced by University of Groningen, in collaboration with Stichting Film en Wetenschap, Utrecht.

30 December, 1 to 3:30 P.M.

The first seven films of the preceding program will be shown again at this time.

AAAS Business Sessions

The Council of the Association will meet 27 Dec. at 4 P.M. in Assembly Room No. 3 of the Hilton Hotel. A second session of the Council is scheduled for 30 Dec. at 9 A.M. in the same room. All members of the Council have been notified, and it is hoped that all can attend. Subjects to be considered by the Council (in addition

to the agenda prepared) usually are first brought before the Board of Directors through the Executive Officer. During the meeting, communications for the Board of Directors should be submitted in writing and left at the Hilton Hotel mail desk, addressed to Dr. Dael Wolfle.

Registration

Main Registration–Information Center. The AAAS Main Registration–Information Center is located in the south lobby of the Hilton Hotel. It will be open as follows: 26 Dec., 8 A.M. to 10 P.M.; 27–29 Dec., 8 A.M. to 8 P.M.; 30 Dec., 8 A.M. to 4 P.M.

Badges and General Programs may be obtained at the supplementary registration desks, but supplementary literature, maps, and the like will be available only at the Main Registration Center. Advance registrants (who will have received programs and badges prior to the meeting) are urged to visit the Main Registration Center at any time to obtain these additional items.

Supplementary Registration Desks. For the convenience of those attending the 128th meeting, there are three supplementary hotel registration desks, at the Brown Palace, Cosmopolitan, and Shirley Savoy hotels. These will be open as follows: *Brown Palace*: 26 Dec., 8:30 A.M. to 8:30 P.M.; 27–28 Dec., 8 A.M. to 8 P.M.; 29 Dec., 8 A.M. to 6 P.M. *Cosmopolitan*: 26 Dec., 4 P.M. to 9 P.M.; 27–28 Dec., 8 A.M. to 8 P.M.; 29 Dec., 8 A.M. to 6 P.M. *Shirley Savoy*: 26 Dec., 9 A.M. to 9 9 P.M.; 27–28 Dec., 8 A.M. to 8 P.M.; 29 Dec., 8 A.M. to 6 P.M.

Registration Fee. The AAAS registration fee, which, intentionally, has been kept at a minimum, is $3. A spouse or child 16 years or over who does not want a separate Program may register for $1 if he or she registers at the same time as the accompanying regular registrant. Each regular registrant receives a receipt, a Convention Badge, and the General Program—the only publication containing the programs of the 18 AAAS sections and of the 88 participating organizations. Any person who purchases an advance copy of the General Program but does not register in advance and who then attends the meeting has agreed to complete his registration, and is expected to do so by paying $1 at the Main Registration Center or at one of the three supplementary registration desks; after this he receives his Convention Badge and the privileges that go with it.

Every thoughtful person will want to register and thus pay his share of the expenses of the meeting. The AAAS Convention Badge indicates that you are participating fully in this 128th convention of the Association. You should wear the badge throughout the meeting because (i) it reminds others to register; (ii) it is needed for admission to the Annual Exposition of Science and Industry, the AAAS Science Theatre, and the reception that follows the AAAS presidential address; and (iii) it helps your friends to find you.

Visible Directory of Registrants. The Visible Directory of Registrants is located in the south lobby of the Denver Hilton Hotel; it is open day and night.

The registration cards of all registrants are placed in the Visible Directory soon after registration. The arrangement is alphabetical. The cards of advance registrants are completely alphabetized and typed, since they are posted prior to the meeting; all other registration cards are filed to the second or third letter of the surname (Ba, Be and so on). Members of the press, exhibitor personnel, and guests are also listed in the Visible Directory—on blue cards instead of yellow. Registrants will find the Visible Directory invaluable in determining the convention addresses of friends attending the meeting.

Mail, Telegrams, and Messages. Mail and telegrams addressed in care of the AAAS will be held at the AAAS Office, off the south lobby of the Denver Hilton. Telephone and personal messages will also be filed alphabetically in the AAAS Office, and the names of those for whom they are intended will be posted on a bulletin board near the Visible Directory. The Association assumes no responsibility for the delivery of mail or telegrams.

Society Meal Function Tickets. Tickets to the dinners or luncheons of any section or any participating society may be obtained from representatives of the section or society, either during preceding sessions or at the Main Registration–Information Center in the lobby of the Hilton Hotel.

Hotel Headquarters

The Denver Hilton is the official headquarters hotel of the AAAS. It is where the Council of the Association will meet and where other business sessions will be held. The Pressroom—for receipt of authors' abstracts and the only source of press releases—is in rooms 540–542.

The AAAS Office, Main Registration–Information Center, Visible Directory of Registrants, AAAS Science Theatre, and Annual Exposition of Science and Industry also are all in the Hilton Hotel.

The headquarters of the 18 sections and of the participating societies follow (the societies are grouped in the same sequence as the letters of the sections with which they are affiliated).

Hilton (884 rooms), 155 Court Place.

AAAS; AAAS Southwestern and Rocky Mountain Division; AAAS Office; AAAS Pressroom.

AAAS Main Registration–Information Center; Visible Directory of Registrants; AAAS Annual Exposition of Science and Industry; AAAS Science Theatre.

AAAS Business Sessions (Board of Directors, Council), General Events, and Special Sessions.

AAAS Committee on Science in the Promotion of Human Welfare; Committee on Desert and Arid Zones Research of the Southwestern and Rocky Mountain Division.

AAAS Sections A–Mathematics, C–Chemistry, E–Geology and Geography, F–Zoological Sciences, G–Botanical Sciences, M–Engineering, N–Medical Sciences, O–Agriculture, and P–Industrial Science.

Association for Computing Machinery, Committee on the Undergraduate Program in Mathematics of the Mathematical Association of America, Society for Industrial and Applied Mathematics.

American Chemical Society, Colorado Section.

Association of American Geographers, Great Plains-Rocky Mountain Division; Geological Society of America; National Geographic Society; National Speleological Society.

American Society of Zoologists, Society of Protozoologists, Society of Systematic Zoology.

American Society of Naturalists; Beta Beta Beta Biological Society; Biomedical Information-Processing Organization; Ecological Society of America; Mountain Lake Biological Station; Society of General Physiologists.

Botanical Society of America.

American Society of Agricultural En-

gineers, Engineering Manpower Commission, Tau Beta Pi Association.

Alpha Epsilon Delta.

American Dairy Science Association, American Farm Economic Association, American Society for Horticultural Science, American Society of Agronomy, American Society of Animal Production, American Society of Range Management, Gamma Sigma Delta, Society of American Foresters, Soil Conservation Society of America.

American Geophysical Union, Conference on Scientific Communication, Conference on Scientific Manpower, National Academy of Sciences–National Research Council, National Association of Science Writers, National Science Foundation, Scientific Manpower Commission, Scientific Research Society of America, Sigma-Delta Epsilon, Society of the Sigma Xi, United Chapters of Phi Beta Kappa, Wilderness Society, Wildlife Management Institute, Wildlife Society.

Brown Palace and Tower (600 rooms), 17th Street and Tremont Place.

AAAS Sections I–Psychology, K–Social and Economic Sciences, and L–History and Philosophy of Science.

Biometric Society, Western North American Region.

Colorado Psychological Association, Colorado Society of Psychologists in Private Practice, Rocky Mountain Psychological Association.

American Economic Association, American Political Science Association, American Society of Criminology, American Sociological Association, American Statistical Association, Institute of Management Sciences, National Institute of Social and Behavioral Science.

American Philosophical Association, Philosophy of Science Association, American Psychiatric Association.

Cosmopolitan (425 rooms), 18th Street and Broadway.

AAAS Sections H–Anthropology, Nd–Dentistry, and Np–Pharmacy.

American Astronautical Society.

American Anthropological Association.

Metric Association.

Society for General Systems Research.

American Physiological Society.

American College of Dentists; American Dental Association; International Association for Dental Research, North American Division.

American Association of Colleges of Pharmacy; American College of Apothecaries; American Pharmaceutical Association, Scientific Section; American Society of Hospital Pharmacists; National Association of Boards of Pharmacy.

American Educational Research Association.

Academy Conference, Colorado-Wyoming Academy of Science, National Aeronautics and Space Administration.

Shirley Savoy (400 rooms), 17th Street and Broadway.

AAAS Cooperative Committee on the Teaching of Science and Mathematics.

AAAS Sections B–Physics, D–Astronomy, and Q–Education.

American Meteorological Society, Sigma Pi Sigma.

American Astronomical Society, Astronomical League.

National Association of Biology Teachers.

Colorado Science Teachers Association, Council for Exceptional Children, National Association for Research in Science Teaching, National Science Teachers Association, American Nature Study Society.

Local Travel Directions

At this meeting, since the four hotels used are all within a few blocks of each other, no travel directions are necessary except, perhaps, directions for reaching the points of interest listed below, which may be obtained at the AAAS Information Center in the Hilton Hotel.

Tours and Points of Interest

At this meeting, there will be no formal tours sponsored by the AAAS as a whole, but certain sections and participating societies have planned tours and field trips, as noted in their programs.

Chamberlin Observatory (East Warren Ave. at South Milwaukee). Tours by appointment, Tuesday and Thursday from 7 to 9 P.M.

Chappell House (1300 Logan St.). Exhibits of American Indian, South Sea, and African art. Open Tuesday through Saturday, 9 A.M. to 5 P.M.; Sundays and holidays, 2 P.M. to 5 P.M.; Mondays, 1 P.M. to 5 P.M.

Colorado Railroad Museum (17555 W. 44 Ave., 2 miles east of Golden on Highway 58). Open daily 9 A.M. to sunset. Open 25 Dec. and 1 Jan. Admission: $0.35.

Denver Museum of Natural History, Botanic Gardens, and City Zoo (City Park, E. 17 Ave. between York St. and Colorado Blvd.). Open Monday through Saturday 10 A.M. to 4:30 P.M.; Sundays and holidays, 12 noon to 4:30 P.M. Closed 25 Dec. and 1 Jan.

Denver Public Library (1357 Broadway). Open Monday through Thursday, 9 A.M. to 9 P.M.; Friday and Saturday, 9 A.M. to 5:30 P.M.; Sunday, 1:30 P.M. to 5:30 P.M. Closed 25 Dec. and 1 Jan.

Living Arts Center, Oriental House, and *Schleier Gallery* (Civic Center). American, European, and modern Oriental exhibits. Open Tuesday through Saturday, 9 A.M. to 5 P.M.; Sundays and holidays, 2 P.M. to 5 P.M. Free.

Sky Deck Observatory (First National Bank Building). Open daily, 10 A.M. to 10 P.M. Admission: $0.50.

State Historical Museum (E. 14 Ave. and Sherman St.). Open daily, 9 A.M. to 5 P.M.; Sundays and holidays, 10 A.M. to 5 P.M. Free.

United States Mint (Delaware and W. Colfax Ave.). Open Monday through Friday. Tours at 9:30 A.M. and 1 P.M. Reservations necessary. Closed 25 Dec. and 1 Jan.

AAAS Public Information Service

The necessity for keeping the general public informed whenever feasible of the results of the scientific research and development which it supports, directly or indirectly, is evident. Organized science and the individual scientist must have the understanding and support of intelligent citizens in all walks of life if they are to contribute effectively to the over-all advance of American democracy. It is, of course, equally important that information for the public concerning advances in science be clearly and accurately disseminated and without sensationalism. Progress in this direction in recent years has been in most instances outstanding, thanks largely to members of the National Association of Science Writers, other accredited science reporters, managing editors of American newspapers, and program managers of radio and television stations.

One of the four objectives of the AAAS is to try to increase public un-

derstanding and appreciation of the importance and promise of the methods of science in human progress. For this reason, and to protect authors of papers from being misquoted by the press, the Association maintains a public information service for each of its annual meetings. Sidney S. Negus, Medical College of Virginia, Richmond, has been director of this service for most meetings since 1938.

During the meeting, in the interest of accuracy and completeness, science writers frequently wish to discuss various research results with investigators. If you are asked to cooperate in this respect or to participate in a press conference, please do so—not only for your own protection but for the benefit of science in general. Scores of science writers will be covering this great scientific convention from the Pressroom in the Denver Hilton Hotel. News stories filed by them will be published and broadcast throughout the world. The assistance of authors in helping to make these stories accurate is earnestly solicited by the Association.

This year, the AAAS is fortunate in having the continued services of Dr. Negus and also the services of its Local Committee on Public Information, headed by Arthur G. Rippey (Rippey, Henderson, Bucknum & Company) and Gerould A. Sabin (director of public relations, Colorado Fuel and Iron Corporation).

Denver Committees

It would be impossible to arrange this large and complex meeting and to carry it through to a conclusion successful in all respects if it were not for the devoted services of many local scientists and other members and friends of the Association. They merit the unstinted appreciation of all who attend. Robert L. Stearns accepted the general chairmanship of the Denver meeting in 1960, appointed the local committees promptly, and has kept in close touch with all phases of committee operations.

General Chairman

Robert L. Stearns, president, Boettcher Foundation.

Advisory Committee

Robert L. Stearns, *chairman.*

Chester M. Alter, chancellor, University of Denver.

Shirley A. Johnson, Jr., director of research, Denver Research Institute.

Walter K. Koch, president, Mountain States Telephone and Telegraph Company.

Carl A. Norgren, president, C. A. Norgren Company.

Arthur G. Rippey, Rippey, Henderson, Bucknum & Company, public relations.

Gerould A. Sabin, public relations director, Colorado Fuel and Iron Corporation.

Committee on Exhibits

Walter K. Koch, president, Mountain States Telephone and Telegraph Company, *chairman.*

R. Grant Athay, associate director, High Altitude Observatory, Boulder, Colorado.

J. Clinton Bowman, president, Bowman Biscuit Company.

Brown W. Cannon, vice president, Beatrice Foods.

Fred G. Coldren, board member, Hallack & Howard Lumber Company.

Harmon H. Davis, sales promotion manager, Colorado Fuel and Iron Corporation.

Charles Gates, Jr., executive vice president, Gates Rubber Company.

Clair G. Henderson, general manager, Rippey, Henderson, Bucknum & Company.

Ray Jenkins, former district manager, J. C. Penney Company, Inc.

J. W. Liddell, vice president, Continental Oil Company.

William W. Mercer, manager, Sears, Roebuck & Company.

Lloyd J. Moyer, assistant general manager, Minneapolis-Honeywell, Heiland Division.

Albert E. Seep, president, Mine & Smelter Supply Company.

Robert M. Stanley, president, Stanley Aviation Corporation.

Paul A. Yetter, vice president, Public Service Company of Colorado.

H. C. Martin, assistant vice president, Mountain States Telephone and Telegraph Company, *secretary.*

Committee on Finance

Carl A. Norgren, president, C. A. Norgren Company, *chairman.*

Cris Dobbins, president, Ideal Cement Company.

Walter B. Hester, director of engineering, Stearns-Roger Manufacturing Company.

Hudson Moore, Jr., president, Walter S. Cheesman Realty Company.

Aksel Nielsen, chairman, Title Guaranty Company; president, Mortgage Investment Company.

Richard H. Olson, vice president and general manager, Sundstrand Aviation-Denver.

Harry St. John, executive assistant, Ideal Cement Company.

Harold F. Silver, president, Silver Corporation.

Charles O. Voight, president, Stearns-Roger Manufacturing Company.

William L. Whitson, vice president, Martin Company.

Herbert Wolff, manager, community relations, Martin Company.

Committee on Physical Arrangements

Shirley A. Johnson, Jr., director of research, Denver Research Institute, *chairman.*

Esther Marie Capps, conference coordinator, University of Denver.

Jay Jaumotte, audio-visual specialist, Martin Company.

Harry Kaufman, director audio-visual services, University of Denver.

Edward Lindell, assistant dean, College of Arts and Science, University of Denver.

Elwood Miller, director, audio-visual services, Jefferson County Schools, Lakewood, Colorado.

Ralph Sellinghausen, superintendent, audio-visual services, Denver Public Schools.

Paul A. Truitt, director, audio-visual services, Englewood School System, Englewood, Colorado.

Eugene Walden, audio-visual director, Cherry Creek Schools, Englewood, Colorado.

Committee on Public Information

Arthur G. Rippey, Rippey, Henderson, Bucknum, & Co., *cochairman.*

Gerould A. Sabin, director of public relations, Colorado Fuel and Iron Corporation, *cochairman.*

Gene Amole, co-owner, KDEN.

Len Berman, publicity director, KTVR.

Chris Burns, head, department of journalism, University of Colorado.

James Case, executive director, KRMA, ETV.

Colbert E. Cushing, director of public information, Colorado Education Association.

Robert de Kieffer, director, Bureau of Audio-Visual Instruction, University of Colorado.

Jack Foster, editor, *Rocky Mountain News.*

William Grant, president, KOA, Inc.

Palmer Hoyt, publisher, *Denver Post.*

John B. Mullins, president, KBTV.

Alberta Pike, public relations consultant.

Committee on Women's Events

This committee is under the direction of the Denver Branch of the American Association of University Women.

Mrs. Donald S. Benny, *president.*

Ann Byrd Kennon, *chairman.*

Honorary Reception Committee

Chester M. Alter, chancellor, University of Denver.

Cyrus W. Anderson, president, Colorado State Medical Society.

Alfred M. Bailey, director, Denver Museum of Natural History.

Louis T. Benezet, president, Colorado College.

S. E. Blandford, president, Denver County Medical Society.

Grant Bloodgood, assistant commissioner and chief engineer, United States Bureau of Reclamation.

F. W. Brown, director, Boulder Laboratories, National Bureau of Standards.

Eugene E. Dawson, president, Colorado Woman's College.

John T. Eastlick, librarian, Denver Public Library.

L. R. Hadley, president, Colorado Chapter, Society of the Sigma Xi.

Byron W. Hansford, commissioner of education, State of Colorado.

Stephen H. Hart, president, Colorado State Historical Society.

G. D. Humphrey, president, University of Wyoming.

Very Rev. William H. Jones, superintendent of schools, Archdiocese of Denver.

Claribell Kendall, secretary, Alpha of Colorado, Phi Beta Kappa.

William E. Morgan, president, Colorado State University.

Quigg Newton, president, University of Colorado.

Kenneth E. Oberholtzer, superintendent, Denver Public Schools.

Tom L. Popejoy, president, University of New Mexico.

Herbert E. Prater, president, Colorado Engineering Council.

Walter Orr Roberts, director, National Center for Atmospheric Research.

William Robert Ross, president, Colorado State College.

Very Rev. Richard F. Ryan, president, Regis College.

Pauline F. Schroeder, superintendent, Jefferson County Public Schools.

Sister Frances Marie, president, Loretto Heights College.

Robert M. Stabler, president, Colorado-Wyoming Academy of Science.

Maj. Gen. William S. Stone, superintendent, United States Air Force Academy.

Thoms C. Tisone, president, Colorado Alpha, Tau Beta Pi.

John W. Vanderwilt, president, Colorado School of Mines.

Annual Exposition of Science and Industry

The AAAS Annual Exposition of Science and Industry will be held on level 2B of the Convention Center, Hilton Hotel. It will be open only to registrants; children under 16 are not registered. All booth space has been sold. Hours: 27–29 Dec., 10 A.M. to 6 P.M.; 30 Dec., 9 A.M. to 4 P.M.

Those who wish to join the Association at this time are cordially invited to visit the AAAS New Member Service, in the AAAS booth in the South Lobby of the Hilton. Whether or not one is a AAAS member, everyone is cordially invited to visit the AAAS booth for information concerning the Association and its activities. Since its founding in 1848, the Association has admitted to membership not only professional scientists but also other men and women who have a general interest in science, who wish to keep informed of the progress of science, and who would like to support the high purposes of the one organization that represents all science. The New Member Service will be pleased to accommodate those who wish to join the Association, and those who are already members can nominate others for membership.

Upon payment of the annual dues of $8.50 (for 1962), each member receives the scientific newsweekly, *Science*, and the quarterly *Bulletin*. Sample copies will be available, and symposium volumes and AAAS membership insignia will be on display. Prospective advertisers may obtain the rate card for *Science*.

AAAS Science Library Program

Booths 92 and 93. Since 1955 the AAAS has administered an experimental science library program with the financial support of the National Science Foundation to encourage the improvement of science and mathematics instruction, to make young people better informed concerning science, to encourage those with appropriate aptitude to choose science careers, and to stimulate the enlargement and improvement of collections of science and mathematics books in elementary schools, secondary schools, and public libraries. An important activity of the program is the continuous staff review and evaluation of science books as they are published, with the advice of qualified specialists.

To aid schools and libraries in selecting and purchasing science and mathematics books, particularly with the aid available under the provisions of the National Defense Education Act and other federal legislation, the AAAS has published *The AAAS Science Book List* (an annotated list for secondary schools and public libraries) and *The Science Book List for Children* (an annotated guide for elementary schools and public libraries). These lists are used as purchase guides by school systems throughout the world. The AAAS will exhibit all of the "double-starred" books (indispensable) and most of the "single-starred" books (highly desirable) recommended in these lists so that they may be examined by scientists, educators, and others. Copies of these lists will be distributed without cost to registrants, as well as copies of the following: *An Inexpensive Science Library*, the 1961 edition of an annotated list of 679 paper-bound science books recommended for high school students, college undergraduates, teachers, and the educated general public; and *Careers in Science*, a new bibliography of career guidance and college information publications prepared especially for secondary school students, teachers, and vocational counselors.

AIM Corporation/Library Publishers, Inc.

Booth 32. Scientists and science teachers will be interested in the Accelerated Instruction Methods Corporation's first showing of the new General Science Programmed Learning Laboratory. In this junior high school general science course, our educational and psychological staffs have employed Skinnerian linear programming techniques to present scientific fundamentals. Difficult concepts are fragmented in these programmed text books in such a way that students are likely to dig out an understanding for themselves. Thus,

the class is able, with better understanding, to go beyond the text into discussion and experiments. In addition, Library Publishers, Inc., will display the newly published titles of *The New Mathematical Library*. This series, designed to present and develop new concepts in mathematics, is being prepared by the School Mathematics Study Group. Each book has been written by an expert in his field and the entire series is being edited by a panel of leading mathematics authorities selected by the SMSG. Another feature of the exhibit is the 1961 edition of the *International Standard Atlas of the World*. Other titles will be displayed, and circulars and catalogs will be available.

Affiliated Publishers, Inc.

Booth 31. We are distributors for Golden Press, Inc., Pocket Books, Inc., and Simon and Schuster, Inc. This is a publishing program which covers the entire elementary science area—from elementary grades to the college level. A variety of titles are available in library binding and hard cover, as well as in quality soft-cover editions.

American Institute of Biological Sciences

Booths 50, 51, and 52. The AIBS exhibit will contain a display of various projects with particular emphasis on the Biological Sciences Curriculum Study, the AIBS Film Series, the Biological Sciences Communications Project, and other publications. Other activity projects of AIBS also will be depicted. AIBS staff members will be on hand to provide information, and a lounge area will be provided for inspection and perusal of publications and brochures. Free copies of the AIBS publications catalog and other brochures will be available.

American Society for Pharmacology

Booth 59. The exhibit will illustrate opportunities in a career in pharmacology. Qualified pharmacologists are in critical demand in universities and in governmental and private research laboratories. College students are often unaware of the opportunities which pharmacology offers to students in biological science since this science is taught only at graduate professional schools. A brochure, *A Career in Pharmacology*, prepared by the Committee on Educational Affairs, is distributed nationwide in order to attract the attention of high school and college students through their advisers and science teachers. Additional information regarding departments offering graduate instruction, their programs and goals, and opportunities offered in research training are made available by the committee to interested science students on an individual basis (supported by NIH Teaching Grant 2G-391).

Association of American University Presses

Booth 35. The member presses of AAUP have sent their most recent publications in scientific fields to this cooperative exhibit. Visitors may examine a wide selection of scholarly books in the biological, medical, and physical sciences; in mathematics and engineering; in social and economic sciences, anthropology, and archeology; and in the history and philosophy of science. Representatives of AAUP will be at the booth to answer questions concerning AAUP and the publications of its member presses, each of which is a separate publishing organization. Free catalogs of the books on display will be distributed. Books may be ordered at the booth or directly from the presses.

Baird-Atomic, Inc.

Booth 21. Baird-Atomic's exhibit will feature the model TF-1 Kopito furnace. This device is based upon a new heating technique which permits classroom demonstrations of most high-temperature physics, chemistry, and metallurgy experiments. Features of the furnace include temperatures over 4000°F within seconds, low-cost, safe operation, complete visibility, economical operation, and a wide range of demonstrations. With this compact heat source, the science instructor and student are able to investigate such phenomena as emission and absorption spectroscopy, ore refining, alloying of metals, enameling and glazing of metals and ceramics, phase transformation of metals, surface tension of metals, characteristics of radiation, and many other experiments where controlled, elevated heats are required. These experiments are described in detail in the manual of experiments provided with each instrument.

Bell Telephone System

Booths 45, 46, 47, 48, and 49. Do you have any questions about E.C.O.? What is E.C.O.? How fast is E.C.O.? How does E.C.O. work? All these questions are answered in the new Bell System Electronic Central Office exhibit. The exhibit tells about the telephone services this new system will offer, and it answers visitors' questions. The world's first electronic central office is undergoing trial in Morris, Illinois. It is the result of one of the most massive single research and development projects ever sponsored by a private enterprise.

Biological Abstracts

Booth 38. *Biological Abstracts* is a scientific information service that reports the world's biological research. The exhibit is designed to illustrate that over 100,000 scientific articles, from more than 5,000 biological journals originating in 83 countries, will be screened and reported in 24 semimonthly issues in 1962 in easy-to-read capsule form. On display will be copies of BA's new *Basic Index*—a current, automated subject index—which will appear in each issue of the journal in 1962. See copies of BTI—*Biochemical Title Index*—BA's specialized, current-awareness service to biochemists and medical researchers, which provides up-to-date references for all the latest research in the biochemical field.

The Book Home

Booth 73. The Book Home is a Colorado Springs firm dealing mainly in scientific and technical books. Besides some rare, old titles in natural science, books of a number of European publishers will be represented. A few of the better known publishers are: Akademie Verlag, Akademische Verlagsgesellschaft, Masson et Cie, Brockhaus Verlag, Springer Verlagsgesellschaft, Walter de Gruyter & Co., Cleaver-Hume Press Ltd., Franz Deutike Verlag, and Wilhelm Ernst & Son. Of special interest should be *Nouveau Traité de Chimie Minérale* (20 vols.) and H. Rind's *Atlas Der Phasen Kontrast Haematologie*.

Brinkmann Instruments Inc.

Booths 54 and 55. Brinkmann Instruments will exhibit Zeiss research microscopes, Brinkmann micromanipulators, Metrohm *p*H meters and automatic recording titrators, Sartorius analytical balances, Brinkmann photomicrographic cameras and exposure meters, and Haake constant temperature circulators.

Cambridge University Press

Booth 4. Cambridge University Press has long been a publisher in the natural and physical sciences—chemistry, phys-

ics, mathematics, biology, botany, zoology. It lists among its authors some of the world's most distinguished scientists, including Sir Charles Snow, Sir Arthur Eddington, Sir James Jeans, George Gamow, Lord Rutherford, Bertrand Russell, A. N. Whitehead, and Sir Charles Sherrington.

Carolina Biological Supply Company Powell Laboratories Division

Booth 37. The new West Coast Division of Carolina Biological Supply Company, Powell Laboratories, will represent the parent company in Denver this year. Plans are being made to provide an interesting and different display incorporating the latest available instructional material. We think you will find many of these innovations useful in your present and planned courses.

Childrens Press, Inc.

Booth 89.

Climax Molybdenum Co.

Booths 42 and 43.

The Coca-Cola Company

Booth 78. Ice-cold Coca-Cola will be served through the courtesy and cooperation of the Denver Coca-Cola Bottling Company and The Coca-Cola Company.

Colorado Fuel and Iron Corporation

Booth 61.

Columbia University Press

Booth 72. All recent Columbia books in anthropology, biology, biochemistry, psychology, and psychiatry will be displayed, as well as recent publications of UNESCO, World Health Organization, and Food and Agriculture Organization in these fields. Catalogs, informational literature, and advance information on new books will be available for exhibit visitors. A cordial invitation to browse is extended.

Consultants Bureau Enterprises, Inc.

Booth 57. In addition to its extensive program of translating and publishing Soviet scientific journals for American learned societies, CB publishes many scientific books and journals translated from Russian under its own colophon. Leading Soviet journals translated on a continuing cover-to-cover basis include: *Biochemistry, Kinetics and Catalysis,* and *Glass and Ceramics.* CB books are carefully selected from current Soviet publications in all fields of science and are translated into English by bilingual scientists, bringing Western researchers, engineers, and teachers the most significant Soviet literature. Some recent titles are: *Analysis of Gases in Metals, Soil Drilling by Vibration,* and *Ball Lightning.* Plenum Press, Inc., publishes the proceedings of conferences held by American and British learned societies, as well as monographs of note. Recent Plenum titles include: *Rocket Propulsion Technology, Fluid and Solid Mechanics,* and *Progress in Industrial Gas Chromatography.*

Continental Oil Company

Booth 19. Continental Oil's exhibit features "Alfol" alcohols, the newest of Continental's expanding line of petrochemical products. Alfols are primary straight-chain alcohols used as chemical intermediates in the synthetic detergent, plasticizer, and lube oil additive fields. The exhibit depicts a large illuminated Alfol molecule, and includes five sketches showing use areas for Alfol alcohols, and sample bottles of ten other Continental Oil petrochemical products. This exhibit was originally prepared as a component of Continental Oil's exhibit at the Fifth World Petroleum Congress which was held in New York in 1958. It has also been displayed in 1959 and 1961 at the Exposition of Chemical Industry in the New York Coliseum.

Cooke Engineering Company

Booth 88. The BAK Amplifier, exhibited by the Cooke Engineering Company of Alexandria, Virginia, and San Mateo, California, is an ultra-high input impedance unity gain amplifier for neurophysiological measurements and recording. An exceptionally high characteristic of stability is featured. The equipment aids in the recording of d-c and high-frequency a-c voltages from high (over 10,000 megohms) impedance sources. It has been used successfully in the recording of resting and action potentials of single neurons. This amplifier may be operated from an a-c transistorized power supply requiring a 60-cycle single-phase 115-volt current source, or by battery voltages controlled through a d-c accessory unit.

The Decker Corporation

Booth 87. The Decker Ophthalmic Artery Pulsenor Model 315-1 is designed to provide quantitative physiological data associated with cerebral circulation, based on the ophthalmic artery being a branch of the internal carotid artery and the circle of Willis. The Decker Caudal Plethysmorgraph System Model 320-1 utilizes the Decker T-42 Ionization Transducer in conjunction with an extremely simple pressure wave monitoring system for pulse rate and systolic blood pressure determinations. Decker Unalec Electrodes with Decaderm Electrode Compound, fastended with Decker skin adhesive, provide a noise free, highly stable electrode system applicable to EEG, EKG, and GSR recording.

Dorsett Controls, Inc.

Booth 25. Dorsett's exhibit includes an operating unit of its Riometer, a recently developed instrument for measuring ionospheric density to radio frequency radiation. This is accomplished by looking through the ionosphere at galactic radiation sources, and by measuring the degree of attenuation, thus determining ionospheric absorption or density. This instrument is a modern tool for evaluation of communication conditions and is popular for radio astronomy and space study applications.

Doubleday & Company, Inc.

Booth 44. Of special interest to both high schools and colleges, Anchor Books features its new paperback series in the sciences: The Science Study Series, published in cooperation with the Physical Science Study Committee, the Natural History Library, and the American Museum of Natural History. Selected Anchor and Dolphin Books in the sciences will also be exhibited. Among the hardbound books on display are: *Doubleday Pictorial Library of Science, Doubleday Pictorial Library of Nature, Doubleday Pictorial Library of Geography,* and *Living Fishes of the World* and *Living Amphibians of the World* (The World of Nature Series).

ERA Research, Inc.

Booth 22. Our exhibit will feature sophisticated equipment designed and tailored to each educational level—elementary, high school, junior college, and university—in the area of electricity, electronics, heat, life science, and mathematics. ERA Research, Inc., offers unique, low-cost equipment for use in teaching the modern sciences. Each unit is composed of modern, up-to-date components and materials, simple to use, and applicable to teaching levels from elementary through high school and university. ERA equipment

eliminates the old-fashioned "black box" approach to scientific equipment, e.g., all wiring and components are clearly visible. One single principle or effect is incorporated into each piece of equipment, thus doing away with unnecessary complexities. ERA products include the Electro-Plot, Model S-200, an electric field plotting system; the incubator, Model U-103, for hatching eggs for life science studies; the Thermobend system, for study of bimetal thermometers and thermostats; and the Transi-Curve, Model T-203, for studying charge and discharge characteristics of capacitors.

Elgeet Optical Co., Inc.

Booth 16. In attendance at the Elgeet booth will be: Mr. David Goldstein, president, Elgeet Optical Co., Inc.; Mr. Robert Lohwater, sales manager, Scientific Instrument and Apparatus Division; and Mr. Louis Marini, Midwest regional manager. On exhibit will be a new closed-circuit television system integrating two Elgeet research microscopes with DuMont closed-circuit equipment. Also shown will be the complete line of student, medical, stereo, metallurgical, and research microscopes being presented by the Scientific Instrument and Apparatus Division of Elgeet Optical Company. A new Zoom microprojector and other scientific optical and electronic instruments will be shown.

Folkways Records & Service Corp.

Booth 85. Folkways Records' documentary recordings, made in the field and laboratory of contemporary life and consisting of sounds found on earth, in the sea, and in space, demonstrate cultures and geography. Annotated and edited by experts in their fields, all recordings are accompanied by detailed, illustrated background notes. Films, filmstrips, and books dealing with the humanities and sciences may also be purchased from Folkways Records & Service Corp., producers and distributors.

General Biological Supply House, Inc. (Turtox Products)

Booth 71. We will welcome any suggestions you make for the betterment of our service and our products. If you are not acquainted with our several publications and our research request feature, our representatives will give complete information on how to avail yourself of these Turtox services.

General Electric Research Laboratory

Booths 1 and 2. Our exhibit will include panels showing a study of superconductors by electron tunneling, the results of work on low temperature chemisorption, achievements in high vacuum, measurements to as low as (10^{-16} mm-Hg), unusual magnetic moments and transitions in iron-rhodium, a new transparent potting compound from silicone, electrical conductivities of α- and β-phthalocyanine, the turbulent structure of a gaseous detonation, and studies at a very high mach number. There will also be demonstrations and apparatus showing defects in silicon crystals introduced by electron bombardment, a plano-plano magnifying lens, a quartz crystal chronometer, resistivity of strained silicon crystals, the relation of magnetic structure to crystal structure and several types of magnetic disorder, and motion from interaction of heat and magnetism.

Graf-Apsco Company

Booth 34. See the new "StereoGraf" low power binocular microscope displayed in our booth; this microscope is American-made and sells at low import prices. Also shown are the Graf-Apsco biological sciences microscopes, as well as representative models of rebuilt microscopes which are "as good as new." We welcome your repair inquiries on *any* make or model microscope.

Grolier Society Inc./Americana Corp.

Booth 23. The Grolier-Americana booth will feature the current edition of *The Encyclopedia Americana* and *The Book of Popular Science*. The *Americana* is a standard, scholarly encyclopedia, particularly strong in its coverage of the sciences. *The Book of Popular Science* is the only general-purpose science reference set correlated with the general science curriculum and published expressly for use in school libraries and in general science classrooms at the junior and senior high school level. Also available at the exhibit will be material correlating Grolier's *The Book of Knowledge* with the elementary curriculum.

Harper & Brothers
W. W. Norton & Company, Inc.

Booth 76. Major Harper science series will be exhibited, including the Science Today Series, hardbound books at quality paperback price; the Harper Modern Science Series under the editorship of James R. Newman, featuring well-known science writers like George Gamow and J. R. Pierce; the college-level Science Library in Torchbook paperback editions; numerous college texts in pure and applied science including Harper's Geoscience Series edited by Carey Croneis; medical books published by Hoeber-Harper; and science juvenile books. A catalog of titles suitable for purchase under Title III of the National Defense Education Act of 1958 is available, as well as catalogs of all Harper departments publishing in the sciences and complimentary copies of *Harper's Magazine*.

Harvard Apparatus Co., Inc.

Booth 75. The Harvard Apparatus Co., Inc., a nonprofit institution, will be exhibiting selected items from its large line of apparatus for research and teaching in physiology and allied sciences. Of particular interest will be the teaching kit of physiological materials designed for secondary school use. Also included will be various infusion-withdrawal pumps, respiration pumps, and peristaltic pumps.

D. C. Heath and Company

Booth 81. At the D. C. Heath and Company booth, where elementary, secondary school, and college science textbooks are exhibited, you can examine the Physical Science Study Committee's new text, *Physics*, and accompanying materials—laboratory guide and teacher's resource book. For elementary schools, we show the 1961 edition of *Health Science Series*, grades 1-8, by Herman and Nina Schneider, the most widely used series. For colleges, in addition to our usual offerings, we show a new edition of Brown's *Biology*, now with a laboratory manual; in chemistry, Martin A. Paul's new *Physical Chemistry*; and for physical science, a brand new book, *Physical Science*, by Omer, Knowles, Mundy, and Yoho of the University of Florida.

High Altitude Observatory–National Center for Atmospheric Research

Booth 10. The exhibit of HAO–NCAR will consist of photographs showing features of research in radio astronomy, coronal research, and chromospheric studies; and a balloon coronagraph with which HAO has conducted coronal and upper atmosphere research. The coronagraph, weighing

1000 pounds and measuring 12½ feet in height, consists of two parts. The frame and pointing mechanism had an illustrious history before HAO acquired it, having served in seven flights to 80,000 feet or more as part of the Stratoscope I series under the direction of Dr. Martin Schwarzschild of Princeton. The second part, the externally-eclipsed coronagraph, was built at HAO in Boulder, Colorado. In 1959, the assembly was flown to 38,000 feet in a manned balloon, and in 1960, it went to 80,000 feet in an unmanned balloon. Photographs taken with the coronograph have been used by Dr. Gordon Newkirk to examine the sun's corona as seen from high altitudes and to measure sky brightness at various angles from the sun. From the latter data, concentrations of various sizes of particulates in the upper atmosphere can be deduced. This is an early step in the analysis of the role high-altitude particulates play in meteorological and other atmospheric processes.

Holt, Rinehart and Winston, Inc.

Booth 53.

Journal of Conflict Resolution

Booth 62. An important purpose of *The Journal of Conflict Resolution* is to stimulate systematic research on international processes. The *Journal* provides a channel of communication for the research and thinking which are already being done, including work directly in this area and work in related areas which is potentially relevant. In addition, the *Journal* enriches the study of international relations by encouraging, within the behavioral sciences, a new area of specialization. Since it is concerned with problem areas rather than discipline, it provides the interdisciplinary context favorable to research on international behavior. The field delineated for the *Journal* is a new one, bridging the gap between the traditional disciplines of history and political science and the new methods of the behavioral sciences. *The Journal of Conflict Resolution* is published by the Center for Research on Conflict Resolution at the University of Michgan. With the December 1961 issue, the *Journal* will be completing its fifth year of publication.

Kaman Nuclear

Booth 7. Kaman Nuclear, a division of the Kaman Aircraft Corporation, introduces the NT 60-9, a new neutron generator specifically designed for activation analysis. This miniaturized accelerator incorporates feed-back control allowing known neutron outputs to be stabilized, thus simplifying the technique of activation analysis for research and industrial applications. In addition, there will be displayed a sub-miniature neutron generator, the NT 1000-1, specifically designed for logging studies and space applications. Kaman's standard generator, the NT 60-8, now widely used in colleges and universities throughout the world for classroom demonstrations and dynamic experiments on sub critical assemblies, will also be on display. In addition, research scientists from Kaman will be on hand to discuss the background of this organization in theoretical studies encompassing all branches of nuclear physics. Attendees are cordially invited to visit the Kaman Nuclear facility in Colorado Springs, Colorado. If classified information is to be discussed, advance clearance should be filed with Kaman's security office.

Keystone Plastics Company

Booth 33. The Keystone Plastics Company of Media, Pennsylvania, are specialists in scientific plastic processing with a proud record of many years' service in this exacting field. A pioneer developer of Acrylic plastic animal caging, Keystone's engineers anticipate the requirements of the discriminating researcher. Refinements to the regular line of Acrylic plastic caging and specialty items are constantly fabricated with improvements. The engineering department is available to design and construct special apparatus, cages, or parts—customized to meet your own specifications. In addition, Keystone manufactures a comprehensive line of stainless steel and aluminum alloy animal caging for small laboratory animals and rodents; roll-away racking for all types of cages; and a new, highly efficient, automatic watering system that may be purchased completely installed or in parts, for installation by your own laboratory technicians. A complete catalog of the regular line and dozens of time- and labor-saving devices is available for the asking.

LaPine Scientific Company

Booths 79 and 80. Leybold physics demonstration apparatus will be featured at the LaPine Scientific Company exhibit in Denver, including a working Plexiglas model high vacuum pump. Many live experiments will be set up, such as: a Leybold vacuum pump with discharge tube showing cathode and positive rays; demonstration model electric motors and generators; a demonstration multirange a-c/d-c meter; an electronic tube and circuit demonstration kit; a Wulf electroscope for radioactivity experiments; a new projector with accessories for projecting live physics experiments; a rotating mirror for classroom measurement of velocity of light by the method of Foucault and Michelson; wave motion apparatus; and a mechanical equivalent of heat apparatus of surprisingly simple construction. Leybold has an exceptionally well developed line of apparatus for teaching atomic physics, and has been a leading German manufacturer of physics-teaching apparatus for over 100 years. Among the LaPine laboratory equipment items on exhibit will be a flash-evaporator, Ainsworth Right-A-Weigh balance, and Sauter Toppan balance.

E. Leitz, Inc.

Booth 77. E. Leitz, Inc., will show the first fully automatic microphotographic camera that fits any microscope and has both detail and field-integrating exposure mechanisms. An outstanding feature is the possibility of determining the correct exposure for a small portion of the field for such difficult specimens as darkfield, phase contrast, and either black and white or color. In addition, Leitz will show their student model HM microscopes for secondary school use, and the simple Prado microprojector for projecting either microscope slides or 2 in. by 2 in. color slides.

Macalaster Bicknell Corporation

Booth 3. We will exhibit and demonstrate all the apparatus kits used in the PSSC Course in physics. New concepts in design and quantity manufacture permit low price levels hoped for by educators, but never before achieved. So valuable to learning, individual student participation in lab work is now possible with no sacrifice in quality, durability, or scientific validity.

Macmillan Company

Booth 65. The Macmillan Company will exhibit books of scientific and technical interest to both the natural and physical science fields. Representatives will be present to discuss our new and forthcoming books.

The Martin Company

Booth 36. The focal point of the Martin exhibit will be a scale model of *Aries*, a space station vehicle conceived by the Martin Company. *Aries* could be used by man to explore the environment of space for prolonged periods of flight in a 350-nautical-mile circular orbit. With our present knowledge and scientific breakthroughs, it should be possible to launch such a vehicle by 1967, then place five men aboard via a ferry space craft. It is expected that booster capability will be available by 1965. A number of leading aerospace companies contributed equipment and valuable scientific data to the Martin Company for the scale model.

McGraw-Hill Book Company, Inc.

Booths 67 and 68. You are invited to inspect the new 15-volume *McGraw-Hill Encyclopedia of Science and Technology*, a comprehensive reference work which presents extensive coverage and concise, factual, basic data in all areas of the physical, earth, and life sciences, and engineering; 7200 articles by over 2000 noted contributors present, in one convenient source, material which previously would have been contained hundreds of books, and in the case of some specialized information, only in periodicals and technical journals. The text is well-illustrated, thoroughly cross-referenced, contains extensive bibliographies, and includes a 548-page index volume with over 100,000 entries. Also on display will be a wide selection of our college- and professional-level technical and scientific books and catalogs for your perusal.

Charles E. Merrill Books, Inc.

Booth 39. Charles E. Merrill Books, Inc., Columbus, Ohio, will exhibit its full line of textbooks, workbooks, skill-texts, and other educational materials. Included in the Merrill exhibit will be new books in the fields of education and psychology, business and economics, physical science, biological science, and engineering. Many of Merrill's new titles will be on display for the first time, as the company has more than tripled its number of new publications in 1961, as compared to the new books it released in 1960. Charles E. Merrill Books, Inc., publishing since 1842, began its "College Division" late in 1958. Since then, this division has seen rapid and dynamic growth in all fields of higher education and professional materials. It is with a great deal of enthusiasm that Charles E. Merrill Books, Inc., offers, this year, its first full-scale exhibit of professional books for the attendees of this significant exposition.

Miles Reproducer Company, Inc.

Booth 74. On display will be the newest "Walkie-Recordall," a lightweight, miniature, briefcase conference recorder-transcriber of maximum efficiency. It records continuously up to 4 hours, in or out of a closed briefcase, and at the same time filters surrounding noises and equalizes voices that are far or near, loud or soft. The Recordall is excellent for recording lectures, staff meetings, conferences, hearings, interviews, round-table discussions, reports, and dictation in the office, or in cars, trains, or planes. There are no wires, plugs, reels, or tapes; the Recordall starts and stops by voice-actuation from a microphone or telephone. Although facilities for transcription are available, transcribing may be eliminated because the nonmagnetic recordings are permanent and cost as little as 3¢ per hour. They are indexed and may be mailed or filed.

Mnemotron Corporation

Booth 27. Mnemotron Corporation of Pearl River, New York, will exhibit multichannel precision analog data tape recording systems for recording physiological variables. On display will be the average response computer CAT for precise measurement of evoked potentials in the brain, cardiological data, phonocardiograms and averaging of other biological variables; and Sonlink, a system of sending physiological variables over a standard telephone with no connection to line.

C. V. Mosby Company

Booth 40. New knowledge, new ideas, new research, and techniques are waiting for you in the Mosby books for the biological sciences. Come in. Look over these books at your leisure and convenience. If you wish their assistance, our representatives will be happy to discuss any book with you.

Muscular Dystrophy Associations of America, Inc.

Booth 82. Our three-panel educational exhibit presents information on muscle and muscular dystrophy. The left-hand panel, consisting of a series of figure drawings with accompanying text, presents the manifestations of muscular dystrophy and a statistical breakdown, by age groups, of the incidence of MD. The center panel is a pictorial view of the recently opened Institute for Muscle Disease, New York City, an MDAA-sponsored project for research into muscular dystrophy and related neuromuscular diseases. The areas of research sponsored by the MDAA grant-in-aid program in quest of the cause and cure for muscular dystrophy are shown in the right-hand panel. Line drawings, with explanatory text, of various animals in which muscular dystrophy occur give visual illustration to the concept that MD is not confined to humans, but appears in many species of animals.

National Bureau of Standards

Booth 20. Using radar methods, the National Bureau of Standards' Central Radio Propagation Laboratory is trying to accomplish two major objectives: To advance the art of ionospheric and exospheric investigation; and to provide data on the features of these regions for regular radio wave propagation predictions services, geophysical research, and analysis of the various phenomena present. The three principal techniques are: 1) vertical incidence sounding of the ionsphere for electron densities and layer heights from the ground; 2) use of a vertical incidence sounding device mounted in a satellite to probe the ionosphere from above—topside sounding; and 3) ground-based, high-power scatter radar installation, principally to measure ionosphere electron densities, kinetic temperature of ions, major ionic components at certain heights, and intensity of the earth's magnetic field.

National Geographic Society

Booth 66. The exhibit of the National Geographic Society will feature the *National Geographic Magazine* and the *Geographic School Bulletins*. Also on display will be maps, books, pictures, and other special educational materials of the Society.

National Science Foundation

Booths 69 and 70. The National Science Foundation exhibit presents in graphic form its programs for promoting basic research, education in the sciences, and dissemination of scientific information. This includes support for scientific investigation, equipment, fa-

cilities, and institutional grants. Education programs are provided for graduate students, as well as for course content improvement—fellowships, institutes, etc. Scientific information programs are aimed at making the results of research more readily available to the nation's scientists. Other activities of the Foundation of interest to AAAS members are those concerned with maintaining the National Register of Scientific and Technical Personnel, making fact-finding studies and analyses of the national research and development effort, and developing national science policy.

New American Library

Booth 83. The Mentor and Signet books on display make it possible for schools and individuals to have an inexpensive "library of science." Seventy-eight of the 679 titles in the 1961 edition of the AAAS publication *An Inexpensive Science Library* are published by the New American Library. All of these books are approved for NDEA purchase. Hundreds of schools and colleges—and the NSF Traveling High School Science Teacher Program—use these science books. Each year a dozen new titles are published. Newest of these is *The Origins of Scientific Thought*, a November book, and first of the five-volume Mentor "History of Scientific Thought" series. Ask for a complimentary copy when you visit Booth 83.

Office of Naval Research

Booth 84. The Office of Naval Research, Washington, D.C., invites you to visit their exhibit illustrating major areas in ONR's training devices program. ONR supports a broad program of scientific research essential to develop future naval capabilities. The exhibit displayed at this year's AAAS meeting pertains to the rapidly expanding science of simulation and its applications to make possible more effective training for fleet operations. The Fleet Ballistic Missile Trainer simulates critical areas of atomic-age submarines, thus permitting training that would otherwise be impossible, dangerous, or expensive to conduct on board the actual submarine. These simulators were developed by the U.S. Naval Training Center, Port Washington, New York, an ONR laboratory, and are used at the shore-based Fleet Ballistic Missile Training Facility, New London, Connecticut.

Ohio Oil Company Research Center

Booth 5. Our exhibit will consist of three panels of photographs, both black and white and color, which tell the story of our company, with emphasis on its applications of the sciences. One panel will show that the Ohio Oil Company engages in all phases of the oil industry, namely, exploration, production, transportation, refining, petrochemicals, and marketing. A second panel will show a colored map of the world and will indicate those countries in which our company has operations. The third panel will have a large picture of our Denver Research Center, with a series of photographs of typical research.

Pergamon Press

Booth 86. Pergamon will display an outstanding group of new books, journals, and reference works. Featured are volumes I and II of the *Encyclopaedic Dictionary of Physics*, which, when completed, will number eight volumes plus a special six-language glossary. Proceedings of the Fifth International Congress of Biochemistry (Moscow) and First International Congress of Pharmacology (Stockholm) will also be available for inspection. Among the new journals that Pergamon is publishing are *Radiation Botany*, *Journal of Psychiatric Research*, *Infra-Red Physics*, *Vision Research*, and *Corrosion Science*. Pergamon, a scientific, technical, and medical publisher, also produces over ninety international journals. Through its affiliate, Gauthier-Villars of Paris, the Press offers an equally distinguished list of publications from the French-speaking world. Through other affiliates—Maxwell, Meier & Holmes and I. R. Maxwell & Co.—complete library as well as journal and periodical subscription services are supplied.

Prentice-Hall, Inc.

Booth 91. Featured at this year's meeting of the AAAS are the newest publications from Prentice-Hall, Inc., designed to meet the educational needs of the scientist, teacher, and student. Included in the display is the complete Foundations of Modern Biology Series (11 volumes). This group of monographs, on major areas of the biological sciences, is a radical departure from the traditional texts available for advanced high school and undergraduate courses. In addition to this series, new text and reference books in the areas of chemistry, engineering science, geography, geology, mathematics, physics, and the like, will be available for your examination.

Public Health Service

Booth 17. The Division of Research Grants exhibit, Grant and Award Programs of the Public Health Service, displays the areas of financial support available from the Public Health Service: Research grants, program grants, research training and fellowships, and health research facilities construction grants. A projector mounted in the exhibit illuminates a series of slides that provide detailed information on the research grants and career development programs. The slides illustrate the review and appraisal of applications, the categories of eligibility, and the various types of grants and fellowships. The Division of Research Grants, a unit of the National Institutes of Health, provides administrative management and policy coordination for the grant programs of the Public Health Service.

Public Service Company of Colorado

Booth 8. Our exhibit consists of a relief map of the state of Colorado and features illuminated gas and electric systems and power plants operated by Public Service Company of Colorado. The map is contained in a large lighted case and is flanked by two smaller panels. The side panels each contain three illuminated color transparencies, which depict a phase of the gas or electric industry in the state. Appropriate descriptive material augments the display, giving pertinent facts concerning the number of people served; extent of the system; and economic value of the Company's investment in property, plant, and equipment.

Reinhold Publishing Corporation

Booth 56. The Reinhold College Textbook Department is displaying a large selection of titles from the company's line of scientific, technical, and college textbooks. In addition to the series *Books in the Biological Sciences* and encyclopedias on the subjects of biology, chemistry, microscopy, and spectroscopy, Reinhold is also introducing a new series of paperbound supplementary textbooks on the basic concepts of chemistry known as *Selected Topics in Modern Chemistry*. There are new textbooks covering cytology,

cell function, plant ecology, advanced organic chemistry, and many other subjects, plus a new 6th edition of the famed *Condensed Chemical Dictionary*. The display presents a broad sampling of Reinhold titles in all scientific disciplines.

W. B. Saunders Company

Booth 18. W. B. Saunders Company invites you to examine their textbooks in biology, chemistry, and medicine. Exhibited for your selection will be the most recent editions of such well-known titles as *Biology* by Villee; *Histology* by Maximow and Bloom: *The Vertebrate Body* by Alfred S. Romer; *Cell Physiology* by Arthur Giese; *Function of the Human Body* by Arthur Guyton; *Textbook of Medical Physiology* by Arthur Guyton; *Physiology and Biophysics* by Theodore Ruch and associates; *Cytology* by DeRobertis, Nowinski, and Saez; *Fundamentals of Ecology* by Eugene Odum; *Comparative Animal Physiology* by C. Ladd Prosser and Frank A. Brown, Jr.; *General Endocrinology* by C. Donnell Turner; *Development Anatomy* by Leslie Brainerd Arey; *Embryology* by B. I. Balinsky; *Chemistry of Organic Compounds* by Carl Noller; and *Psychology* by Donald I. Hebb. Representatives of the firm will be on hand for consultation and advice during the meeting.

Scholastic Magazines, Inc.

Booth 60. Scholastic Magazines will exhibit *Science World*. Published biweekly during the school year, *Science World* presents important developments on today's frontiers of science correlated with the secondary school science curriculum (edition 1 for general science, earth, and space science classes—grades 10-12; edition 2 for classes in biology, chemistry, and physics—grades 10-12). *Science Teacher's World*, the teacher edition, includes teaching guides, classroom projects, and articles of professional interest. *Science World* is published with the official cooperation of the National Science Teachers Association. Science World Book Club (grades 7-12) offers a new list of top-rated science books in inexpensive paperback editions, to enrich the secondary school science program. Titles include science history, biography, mathematics, experiments and projects, philosophy of science, and reports on major breakthroughs in science and technology.

Science Library

Booths 12, 13, and 14. The Science Library is administered by the AAAS as an additional service to publishers of books, both exhibitors and non-exhibitors. It has become an integral part of each year's Annual Exposition of Science and Industry. In the Science Library, books of all publishers participating are grouped by fields of science —a convenience both to the visitor who is restricting his inspection of books to a single category, and to the one who wishes to browse. Among the publishers in the Science Library are: AAAS, Academic Press Inc., American Mathematical Society, Annual Reviews, Inc., Antioch Press, Bantam Books Inc., Barnes & Noble, Inc., Burgess Publishing Co., Consultants Bureau Enterprises, Inc., Coward-McCann, Inc., John Day Co., Dial Press, E. P. Dutton & Co., Inc., Emerson Books, Inc., W. H. Freeman and Co., Harper & Brothers, Houghton Mifflin Co., Institute for Scientific Information, M.I.T. Press, National Academy of Sciences–National Research Council, New American Library of World Literature, Inc., Oxford University Press, Inc., Plenum Press, G. P. Putnam's Sons, Reinhold Publishing Corp., Charles Scribner's Sons, Charles C. Thomas, Publisher, University of Miami Press, University of Tennessee Press, University of Toronto Press, Viking Press, Inc., Franklin Watts, Inc., and World Publishing Co.

Scientists' Committee for Radiation Information

Booth 28. Scientists increasingly recognize a responsibility to inform the larger community in areas where science impinges on public policy [*Science* **132**, 68 (1960)]. This exhibit demonstrates the range of activities that scientists' groups have developed and can pursue in their own communities to promote better understanding of such issues as ionizing radiation. Sources of factual information available to the nonspecialist scientist in speaking before the public are described, and sample literature and bibliographies will be distributed.

Sesco, Inc.

Booth 6. Sesco is a subsidiary of Universal Scientific Company, Inc., which specializes in the field of science apparatus. The Sesco units on exhibit will include representative items in the field of chemistry, general science, mathematics, and physics. These units are recent developments and have been evaluated by an impartial staff of practicing educators with regard to their functional design and teaching effectiveness. Many of the units serve areas in which suitable apparatus previously has been unavailable. Detailed specification sheets explain the operation of each unit and the more complicated units contain, in addition, a detailed manual of experiments.

Special Libraries Association Colorado Chapter

Booth 11. Part of the exhibit will be supplied by the SLA Translation Center at the John Crerar Library of Chicago. This exhibit consists of three panels: the first panel is a photomontage that points out the importance of foreign scientific research; the second panel displays all the publications of the Translation Center and announces the available translations; and the third panel displays photostatic and microfilm copies of translations that are supplied upon request.

Stearns-Roger Mfg. Co.

Booth 26. Our exhibit will feature saline water conversion as it is being accomplished at Freeport, Texas, the first operating demonstration plant of the Office of Saline Water, U.S. Department of Interior. The Freeport demonstration plant utilizes the long tube vertical, multiple-effect distillation which will produce one million gallons of fresh water per day. Saline water conversion will be demonstrated in this booth through the use of graphic and photographic illustrations. Technical personnel from the operating company, the Stearns-Roger Mfg. Co., and possibly from the Office of Saline Water, U.S. Department of Interior, will be available to explain the operation of the Freeport plant. Printed material on the history and development of the Saline Water Demonstration Program will be available for all visitors.

Sundstrand Aviation-Denver

Booth 9. Sundstrand Aviation-Denver will exhibit a full-scale mock-up and sectional drawings of a Cryogenic Space Power System being developed under a U.S. Air Force Systems Command contract. Named the Cryhocycle, it is a cryogenically fueled, fully inte-

grated space power generation and thermal control system. Powered by cryogenic hydrogen and oxygen, this system is unique in that normally wasted heat, from energy conversion inefficiencies, and metabolic heat, from the crew of the space vehicle, is recovered by the coolant loop and returned to the power cycle by interstage reheaters between each of the four stages of a single-disc turbine. This results in specific propellant consumption economies which have not been achieved by any other dynamic system for space power. In addition, the entire system operates at room temperature, eliminating a need for high-temperature materials, solving wheel containment problems, and greatly improving the inherent reliability and safety. Several versions of this space system are being developed which will be suitable for missions of several weeks' duration, at power levels that range from 1.5 kilowatts to 50 kilowatts.

Teaching Materials Corporation

Booth 24. The Teaching Materials Corporation exhibit will feature teaching machines and programed courses for use in elementary and secondary schools, colleges, business, industry, government, and home study. Teaching Material Corporation's current offerings include courses in arithmetic, algebra, statistics, and electricity. Eventually, Teaching Materials Corporation will program elements of all science subjects on the elementary, secondary, and college levels. The exhibit will feature the new Min/Max machine—a durable, light-weight, plastic machine to which an answer tape is attached, permitting multiple use of programs.

Tobacco Industry Research Committee

Booth 15. The scientific research program developed and directed by the Scientific Advisory Board to the Tobacco Industry Research Committee is described. The research program, covering all phases of tobacco use and health, contains three main areas of investigation within which are the specific fields of research. These areas and specific fields are described. Grants-in-aid have been awarded so far to more than 110 scientists in 755 institutions, and recipients have published over 200 papers to date on their research in medical and scientific journals.

United Western Laboratories, Inc.

Booth 90. A sterilizer of medical instruments under cold conditions, known as the Powers Cold Instrument Pathogermicide, was formulated in the laboratories of United Western Laboratories, Inc., some years ago by their chief chemist and pharmacist, Emmett Powers. This combination, a compatible mixture of many well-known ingredients, has been known and used over a period of many years by hospitals and professional laboratories. It quickly destroys such pathogenic spores as tetanus, anthrax, and the wax-coated tubercle bacilli. It is effective at 40° to 50° below zero. The Powers Pathogermicide also has been found to prepare a skin before operation quickly, without causing irritation. It is sold only to professional people.

University of Chicago Press

Booth 41. The University of Chicago Press exhibit will feature the new Phoenix Science Series, inaugurated in paperback form with reprints of nine titles and with one original publication, *A Handbook of Biological Illustration*. Recent and important hardbound books will also be displayed, and late issues of scientific journals published by the Press will be available for examination.

D. Van Nostrand Company, Inc.

Booth 29.

Van Waters & Rogers, Inc.

Booth 58. Van Waters & Rogers, Inc., has three divisions: Braun, B-K-H, and Scientific Supplies. Our exhibit will display a variety of the latest available scientific apparatus and instruments. This equipment will be of interest to those in a wide range of disciplines, including the life sciences, physical sciences, education, and the clinical scientific laboratory field. Included in our exhibit will be the Mark II AutoTutor Teaching Machine; the first western showing of the Type S Mettler Digital Analytical Balance (a new approach to perfection in weighing); the latest developments in American and imported microscopes; and the newest analytical instruments of such manufacturers as Baird-Atomic, Beckman Scientific and Process Instrument Division, and Coleman Instruments, Inc.

Ward's Natural Science Establishment, Inc.

Booth 30. Ward's is celebrating its 100th year of service to American education. Ward's display centers around several of the interesting teaching aids developed especially for our Anniversary Year, including the popular new Curriculum Aid series for high school use. Featured also are bio-plastic mounts, pioneered by Ward's in 1946. Of particular interest is the new plant kingdom collection in bio-plastic with carrying case. For the geologist there are mineral collections and specimens. Teachers of biology and geology are cordially invited to visit Ward's display and meet staff members from both Rochester and Monterey.

Welch Scientific Company

Booth 64. The Welch Scientific Company plans to display selected apparatus used in physics, chemistry, and biology laboratories. These will include those especially adapted to the teaching of science in the secondary schools and colleges, as well as some items specifically designed for special use in research and industrial laboratories. A partial list includes stainless steel balances; quick operating, high vacuum pumps; electrical measuring instruments; electronics teaching devices; Densichron for measuring optical density, color saturation, paper chromatograms, etc.; and new, enlarged mathematics models. Many charts and visual aids for teaching science, mathematics, and physiology, as well as preserved specimens, synthetic skeletons, and other biological models will be shown.

John Wiley & Sons, Inc.

Booth 63. John Wiley & Sons, Inc., cordially invite you to visit our booth at the 1961 AAAS Exposition of Science and Industry, where a wide selection of our college and professional level scientific and technical publications will be on display. Our representatives look forward to meeting and talking with you there. Naturally, we hope that you will spend a few minutes in browsing through the titles on exhibit. Parratt's *Probability and Experimental Errors in Science* and Core, Strausbaugh, and Weimer's *General Biology* (ed. 4) are just two of the many important new Wiley books that will make your visit to Booth 63 a stimulating one.

Science and the News

Science and Segregation: The American Anthropological Association Dips into Politics

"Any man with two eyes in his head," Carlton Putnam notes in his *Race and Reason*, "can observe the pure blooded African in his native habitat as he exists when left on his own resources, can compare this settlement with London or Paris, and can draw his own conclusions regarding the relative levels of character and intelligence." Putnam is former chairman of the board of Delta Air Lines, former president of Chicago and Southern Air Lines, and more recently a biographer of Theodore Roosevelt. He has taken time off from the preparation of his multi-volume work on TR to write *Race and Reason: A Yankee View*, which questions the Supreme Court decision on school segregation on the grounds that the decision is based on a perversion of science invented and popularized by minority group scientists. This perversion, Putnam says, denies the inferiority of the Negro race. He hopes that once the true scientific facts can be put before the public, the country will realize the mistaken basis of the court decision, and something can then be done to reverse it. As T. R. Waring, editor of the Charleston (S.C.) *News and Courier*, points out in his foreword to *Race and Reason*; "To those who recognize that the salvation of the South lies in the education of public opinion rather than in rear-guard court actions, and that our national leaders must be told the scientific as well as the political facts of race, this book will be indispensable."

The Louisiana State Board of Education quite agrees with Waring's evaluation of the book. "An eminent American anthropologist and scholar," said the Board, referring to Putnam, "has recently written a book that exposes the flagrant distortion and perversion of scientific truth by so-called social anthropologists and socialistically oriented sociologists." In view of this, the State Board of Education made the book required reading for "selected college personnel," including "1) All deans, professors, and other instructional personnel. 2) All students enrolled in courses in Anthropology, Sociology, and Psychology. 3) All students enrolled in the required course in Americanism vs. Communism." In addition, the book will be required reading for high school students, but only those specially selected on the basis of "maturity, sincerity, and dependability."

Governor Ross Barnett, of the neighboring state of Mississippi, was so impressed by the book that he officially proclaimed 26 October 1961 Race and Reason Day throughout the state. "The people of Mississippi are fortunate indeed to have a scholar of Mr. Putnam's standing visit our state and address our people," said Barnett, suggesting that the occasion be observed by "reading and discussing *Race and Reason*, calling the book to the attention of friends and relatives in the North, and by participating in appropriate public functions."

Somewhat further east, the governor of Alabama has also taken steps to establish the scientific facts of race. In February he made a grant of $3000 to Wesley C. George, professor of anatomy at the University of North Carolina, in order that Professor George might make an impartial study of the question. George, along with three other scientists, contributed an introduction to Putnam's book, vouching for its "inescapable scientific validity." His evaluation of race differences will be ready for Governor Patterson shortly.

Anthropological Association

The American Anthropological Association took note of this scientific effort by passing a unanimously supported resolution at its annual meeting last month. The resolution was framed to win the support of three mildly divergent views among the 192 anthropologists at the meeting: those who feel it has been scientifically established that there are no significant mental or emotional differences between the races; those who feel that the question has not been firmly settled; and those who feel there is some evidence for marginal racial differences, but not for any differences marked enough to support a view that one race is inherently inferior to another.

"The American Anthropological Association," the resolution begins, "repudiates statements now appearing in the United States that Negroes are biologically and in innate mental ability inferior to whites and reaffirms the fact that there is no scientifically established evidence to justify the exclusion of any race from the rights guaranteed by the Constitution of the United States."

George has responded with a letter to the New York *Times* reporting that it was "amazing to me" that the Anthropological Society would attempt to decide a scientific question by submitting it to a popular vote or passing a resolution. He said that a similar vote had condemned Galileo's belief that the earth moved around the sun.

Response

Putnam took more direct action and called a press conference to read a statement accusing the association of "deceiving the American public." He invited the association to "throw off the yoke of the hard core radicals." "The hour has passed when American scientists could afford the luxury of indulging alien ideologies in their midst."

Putnam did not want to specifically name the minority group he felt was particularly responsible for the distortion, but in answer to a direct question from a reporter he allowed that they were Jews. He said he could not understand why Jews would want to do such a thing, since they themselves are not considered inferior. "Quite the contrary," he said. The Mississippi Citizens Council, for its part, was preparing a film of Putnam's talk at a banquet held in his honor during the state's Race and Reason Day. The film will be distributed as part of the Council's "Project: Understanding."

Putnam says he does not know when he will be able to get back to his biography of Teddy Roosevelt, since his book on race, he has found, has made him a central figure in the effort to cor-

rect the perversion of scientific truth he feels has been sold to the American people. He says he does not claim to be a scientist himself, but that he sees himself as counsel for what he feels is the great number of anthropologists and geneticists who have been forced to keep silent their true views on the racial question for fear of retaliation. He naturally refuses to name any of these men, but he tells of a scientist who wanted to be assured that Putnam was not followed when he visited his home, and another who assured him that he had evidence that "his lectures were being checked on by mulattoes."

Resolution

The Anthropological Association's response to this renewed effort to claim a scientific basis for segregation was the resolution quoted earlier, which was, in itself, a restatement of a formal position it had taken several years ago in response to an earlier group of statements on racial inferiority. The affair, as it could not help doing, put the association in an awkward position. The resolution it passed was a political rather than a scientific statement: it was mildly but deliberately ambiguous. The first clause "repudiates" the view that Negroes are inferior. The second clause, though, does not affirm the opposite of what the first clause repudiates: it does not say that Negroes are not inferior, but that there is no scientific basis for denying them any share of the constitutional rights available to other citizens. Translated into blunter language, the statement might have said that while the anthropologists differ among themselves about the extent, if any, of congenital racial differences, they agree that there is no proof to give a policy of enforced segregation a scientific basis, and that while there may be evidence of racial differences, the suggested differences are not so firmly established or so uniformly favorable to any one race that they can support a flat assertion of the inferiority of another race.

The difficulty the anthropologists faced was the political problem that any recognition that there might be racial differences would be used by racists to support their own side, as is done, for instance, by Putnam, with quotations from authors who think the racist view is preposterous but agree that racial differences probably exist. From the other side, the association, in order to get unanimous support for its resolution, had to meet the objection of the minority at the meeting who felt that there was affirmative scientific proof that no racial differences exist. The result was the negative clause repudiating the claim of the white supremacists that racial superiority had been proved, and the affirmative clause, making the more general assertion that there is no scientific basis for treating Negroes as second-class citizens.

The problem the association faced in wording its resolution is one faced continually by scientists working in the field, where Putnam is undoubtedly correct in saying that scientists are wary of speaking frankly on racial matters. This does not mean that Putnam is correct in claiming that many scientists would support his view if they felt free to speak. An indication of this is that even in the South, where a scientist would presumably feel free to speak out without much fear of being ostracized, or of losing his chances for promotion, there are very few men of any prominence who have supported the racist view. There are, however, a large number of scientists who feel there probably are racial differences, who feel, indeed, that it would be most surprising that groups living apart for so long that they have developed obvious physical differences had no differences at all beyond the physical differences, and yet who feel constrained to be very careful about what they say publicly, for it is almost impossible to say anything without on the one hand being suspected of being a racist, and on the other hand, of having whatever is said quoted out of context to support the racist view. It is very difficult to talk of possible racial *differences* beyond the most obvious physical ones without having the racists, and often the strong egalitarians as well, assume you are endorsing the idea of racial *inferiority*.

Dilemma

There is no easy way out of this dilemma. Being a scientist rather than a politician does not make a man unaware of, or unconcerned about, the practical effects of what he says. Yet the scientist who is cautious about what he says in public about race faces the charge that he is letting political considerations interfere with his scientific objectivity. He also leads men like Putnam and the few scientists for whom he speaks to feel that there is a conspiracy afoot.

The scientist speaking on a subject with unavoidable political implications has no comfortable way out unless he happens to hold an extreme (although not necessarily unsound) view. In this racial matter, those who have no difficulty deciding what to say are the men who hold that there cannot possibly be any racial differences not attributable to environment, or, on the other side, those who feel that there are, as George and his colleagues claim, "vast differences" which justify a policy of legally enforced segregation to prevent the degeneration of American civilization. The men in the middle cannot say much of anything without being attacked from one side and having their statements misused by the other.

There is, of course, the possibility of saying nothing, or at least nothing written in nontechnical language for the general public. The problem here, in the view of the Anthropological Association, is that George and the three co-signers of the introduction to Putnam's *Race and Reason* had issued, in effect, a public manifesto asserting they, as scientists, vouched for the scientific validity of Putnam's views. As the scientific body most directly concerned, the anthropologists felt they had a public responsibility to issue a statement making very clear that the great majority of men in this field regard George's views as hokum. To George's complaint about the impropriety of deciding a scientific question by passing a resolution, a spokesman for the association replies that George and his colleagues have done much the same thing in writing their introduction, and that they have nothing to complain of if a much larger body of scientists releases a similar public statement repudiating the racist view.

The association will try to put together a more precise statement of the question of racial differences, but a measure of the difficulty it foresees in working out something suitably "objective" and "scientific" is that the statement, it is expected, will probably take about a year to prepare. It will not be terribly surprising if it never appears at all, for it is a good deal easier to agree to make a statement of the objective facts of a political issue available to the public, than to get agreement on just what an objective statement of facts ought to contain.—H.M.

Disarmament Agency: It Is Off to a Slow Start

The new-born U.S. Arms Control and Disarmament Agency has shown no signs to date of being an especially vigorous infant.

Among those who helped the agency win congressional approval, there is understanding and sympathy for its slow start, but elements of annoyance and concern are also becoming evident. In the view of one White House aide, the agency would benefit from some strong prodding.

The establishment of the agency, at the end of September, was regarded by its backers in Congress and the Administration as a long-overdue step for bringing continuity and high-caliber personnel into U.S. disarmament efforts. It was pointed out during congressional hearings that U.S. disarmament negotiators had in the past been hurriedly assembled to meet their Soviet counterparts, and that they had frequently been hampered by inadequate staff preparation. The agency also came to be regarded as a means for giving disarmament institutional standing and a forum amidst almost unanimous calls for increased armament. And, at one extreme, the agency was foreseen as the friend, cultivator, and center of disarmament interests, much as various other government agencies seek to further particular interests.

In view of Soviet truculence and the Administration's desire to harmonize agencies dealing with foreign policy rather than throw them into competition, this last view was not a reasonable appraisal of the attainable roles open to the agency. Measured, however, in terms of what it has accomplished so far in simply setting up shop, the agency has little to show. Its officials stress that the conditions that have hampered them from the start will not change quickly, and that they do not foresee any swift burgeoning of the agency's size or influence. Its critics contend that it has been paying too much attention to its difficulties and too little to its opportunities.

The principal difficulties cited by the agency are money and the cumbersome security system imposed on it by Congress. In terms of the Defense budget, the amount involved is piddling, but the manner in which the budget has been treated supports the view that congressional suspicions of the agency are still lively, despite the overwhelming votes in both houses for the act establishing it.

The act provided for a $10 million budget, without any time limit on its expenditure. At the date of passage, the agency inherited about $1 million from the State Department's Disarmament Administration, which was its predecessor. An additional $4 million for the current fiscal year was requested, but in a House-Senate conference in the last days of the session, this was cut to $1 million. The agency thus went into operation with $2 million at its disposal. Its staff from the outset consisted of the approximately 80 persons in the Disarmament Administration. The fund limitation, however, curbed its intention to expand to about 250 persons. The stringent security system that it was required to follow placed restrictions on the speed that it could hope for in any expansion, no matter how small. Under the security standards, all applicants must undergo full field investigation. These generally take from 60 to 90 days, but it is not unusual for them to last as long as 6 months. The delay involved frequently discourages persons interested in joining the agency, while the fine-tooth approach toward loyalty and security tends to persuade those with less-than-orthodox views on disarmament that it would be fruitless for them to seek employment.

Interim Appointments

The agency, incidentally, is not permitted to make interim appointments pending completion of security investigations. Other agencies have found interim appointments to be an extremely useful device for getting new personnel to work while their background investigations are under way. Under the interim method, the agency director vouches for the employee's acceptability, but this course was denied to the Arms Control and Disarmament Agency.

Further restricting the agency in its recruiting is the old problem of government-versus-private salaries. Subsequent legislation provided the agency with 14 "supergrade" positions, with salaries ranging from $15,000 to $18,500 annually. Those qualified to make useful contributions in the enormously complex area of disarmament can almost always command more money from nongovernmental sources. At present, according to an agency official, applicants for seven supergrade positions are undergoing security clearance. None of the supergrade positions has yet been filled.

The bipartisanship emphasized by Kennedy in filling foreign policy posts which touch on domestic political sensitivities is reflected in his selection for the head of the agency. His choice was William C. Foster, a Republican businessman with a long record of distinguished service in various difficult government posts, who is immune to any attempt to read appeasement into his services in behalf of disarmament. The likelihood of such attempts ranked high in the Administration's thinking in framing the bill, and as a result the agency came into being heavily armored against potshots from the right. The concern being voiced among some of its supporters is that the armor is proving cumbersome and that it is carried at the cost of imagination and fresh ideas in the gloomy field of disarmament.

Staffing

The agency's officials point out that Foster, who is highly regarded as an administrator, believes in permitting his chief subordinates to pick their own staffs. Under the restrictions of money and security clearances, almost all of the newly created middle-level positions will therefore remain unfilled until Foster's immediate subordinates have taken office.

Paralleling recruitment as a concern is the place that the agency is making for itself in relation to the other agencies directly involved with disarmament. These are principally the State and Defense departments and the Atomic Energy Commission, all of which are bigger, older, and more deeply entrenched on the Washington scene. In testifying on the disarmament agency bill before the Senate Foreign Relations Committee last August, Henry Cabot Lodge, drawing on his own experience as a disarmament negotiator, warned of what would lie ahead for the director of the agency in dealing with other branches of the government.

"We may as well face the fact," he said, "that the man who occupies this post will have to step on a great many toes. There will always be sincere differences of view in the various agencies of Government on matters which are as far-reaching and which involve the most vital interests of the country.

"After the director has exhausted the procedure of trying to compose the differences between the departments them-

selves . . . he must go up to the President."

The right to appeal to the White House is explicitly written into the bill, but this does not alter the fact that to a very large extent the agency must make its way by its own efforts.

Agency personnel have noted that in various ways the major Executive departments find it hard to accept the new arrival as the focal point for the nation's disarmament efforts. The relationship in such matters is subtle, and the grounds for complaint are difficult to establish. But it is claimed that the State Department, for example, has been slow in getting accustomed to the fact that disarmament is now the responsibility of an agency independent of its control. Its predecessor, the Disarmament Administration, was a small, not very significant branch of the State Department. The new agency is housed in the State Department, in the same offices, and depends on the State Department for housekeeping services. In the act, however, it is given "primary responsibility within the Government for Arms Control and Disarmament matters."

Public Attention

Those who feel concern for the course it is taking believe that stepping on toes, as predicted by Lodge, is unavoidable if the agency is to fulfill its legislative mandate. They would also like to see the agency draw attention to itself as the governmental arm responsible for working toward disarmament. Other newly established agencies, such as the Peace Corps and Food for Peace, have carefully cultivated constituencies, and have found them valuable for getting their work done. At present, little is seen or heard of the agency, and in its relations with its elders in the Executive Branch, it appears to be quiet and courteous.

One source of this behavior is unquestionably a healthy regard for the money powers of Congress. By doling out only a pittance for the agency's establishment, the Appropriations Committee in effect served a warning that further support would depend on good behavior.

The difficulties attached to the agency's existence cannot be discounted. But among those who helped bring the agency into being, there is the feeling that these early days are crucial for its future, and that if it is going to fulfill its role it had better get moving.—D.S.G.

Announcements

The Department of Defense has adopted an **instruction policy on experimental animals** which requests that "laboratory animals be treated with due professional and ethical consideration," since ". . . the use of animals in research has proved to be a sensitive subject among various groups of the United States and foreign countries." The policy, released in September, states that all DOD-sponsored programs involving animals will be conducted according to the principles of the National Society for Medical Research; that laboratory staffs and facilities must provide "all necessary support services such as veterinary care and trained service personnel . . ."; and that material for release to the public "should, whenever feasible, contain full information relevant to humane procedures utilized and other evidence of excellent animal care." (National Society for Medical Research, 920 S. Michigan Ave., Chicago 5, Ill.)

Research scientists, including biologists, are invited to use the facilities of the **Inter-University High Altitude Laboratories** (Massachusetts Institute of Technology, University of Colorado, University of Denver) for research that would be facilitated by the locale. The laboratories have extensive year-round installations at Echo Lake (elevation 10,600 ft), and summer facilities at Mt. Evans, Colo. (elevation 14,150 ft). (Mario Iona, Physics Department, University of Denver, Denver 10)

A **national mineral collection**, reported to contain specimens representing approximately 30 percent of the world's known mineral types, has been established at Ottawa, Canada. The collection consists of a systematic reference series, to be maintained by the Geological Survey of Canada, and a display series located in the National Museum. (Department of Mines and Technical Surveys, Information Division, Ottawa)

A **solar reflector** to test materials for outer space vehicles has been developed by Goodyear Aircraft Corporation's Arizona division. The 8-foot parabolic dish is capable of creating and focusing an estimated 350 British Thermal Units (6000°) per square foot per second, and will be used on metals, ceramics, sublimation cooling coatings, and thermal plastics to determine their resistance to the heat they will encounter in space and during atmosphere re-entry. (Goodyear Information Bureau, Akron 16, Ohio)

Courses

A 16-session course in **photography for education and research in biological sciences** will begin on 17 January at the University of Illinois. Tuition: $30. (George McGregor, University of Illinois Department of Non-academic Personnel, 1853 W. Polk St., Chicago)

A doctoral program in **geology and related earth sciences** has been established by the University of Nevada's Mackay School of Mines. The Bureau of Mines and the Mining Analytical Laboratory, branches of the school, offer research facilities and opportunities for graduate employment as field and laboratory assistants. (Mackay School of Mines, University of Nevada, Reno)

Grants, Fellowships, and Awards

Twenty-five **agricultural research associateships** for 1962–63 are being offered by the U.S. Department of Agriculture and the National Academy of Sciences. Applicants having a doctoral degree may apply for work in biochemistry, entomology, genetics, microbiology, physical and microbiological chemistry, and physiology, virology, or mineral nutrition of plants. The stipend will be $8955. Deadline: *1 February 1962*.

Other research associateships are available at the National Bureau of Standards, the Naval Ordnance Laboratory, the Naval Research Laboratory, the Naval Weapons Laboratory, the Navy Electronics Laboratory, the Army Chemical Corps Biological Laboratories, and four technical centers of the Air Research and Development Command. (Fellowship Office, NAS, 2101 Constitution Ave., NW, Washington 25, D.C.)

Two Ogden Mills fellowships of $5000 for research in **anthropology** are available at the American Museum of Natural History. Preference will be given to candidates in their early

postdoctoral years. Applicants should submit a full *curriculum vitae*, a letter describing research aims and the proposed program for the fellowship year, and three letters of recommendation. Deadline: *1 February 1962*. (Harry L. Shapiro, Department of Anthropology, American Museum of Natural History, New York 24)

A graduate fellowship for **polar or alpine research** in the fields of botany, agronomy, geology, photogrammetry, bacteriology, geography, or other pertinent sciences, is available at Ohio State University's Institute of Polar Studies. The stipend is $2800.

The institute is also offering a graduate summer exchange fellowship for polar research in the fields of botany, agronomy, glaciology, glacial geology, geomorphology, and lake sedimentology. The $750 stipend is expected to cover room and board, and transportation costs to a summer field station at Kbnekajse, Sweden. Deadline: *15 February 1962*. (Dean, Graduate School, Ohio State University, 164 W. 19th Ave., Columbus 10)

Meeting Notes

A symposium on **current trends in nuclear power** will be held from 26 February to 2 March 1962 in Tucson, Arizona. The program will cover prospects and problems of generating electrical power from nuclear energy, advanced nuclear reactor concepts, current status of research on creating power from a controlled fusion chain reaction, and developments in nuclear engineering education. (Lynn Weaver, Nuclear Engineering Department, University of Arizona, Tucson)

An international congress on **human factors in electronics**, sponsored by the Institute of Radio Engineers, will be held from 3 to 4 May 1962 in Long Beach, California. Papers presenting new research findings and dealing with problems of human factors are solicited in the following areas: automatic control, biological science, communications, computers, cybernetics, electrical engineering, information theory, mathematics, medicine, and psychology. Deadline for receipt of 300-word abstracts: *1 January 1962*. (Charles Hopkins, Hughes Aircraft Company, Culver City, Calif.)

New Journals

Bio-medical Purview, vol. 1, No. 1, Fall 1961. E. J. Simonsen, Ed. National Society for Medical Research, 111 Fourth St., SE, Rochester, Minnesota. Quarterly. $10 per year; single copies, $2.50.

British Journal of Social and Clinical Psychology, vol. 1, No. 1, Feb. 1962. M. Argyle and J. Tizard, Eds. Cambridge University Press, 32 E. 57 St., New York 22, N.Y. Triannually. $8.50 per volume; $3.50 per copy.

Experimental Eye Research, vol. 1, No. 1, Sept. 1961. E. A. Balazs and H. Davson, Eds. Academic Press, Inc., 111 Fifth Ave., New York 3, N.Y. Quarterly. $16 per annum.

Experimental and Molecular Pathology, vol. 1, No. 1, 1962. F. Coulston and W. A. Thomas, Eds. Academic Press, 111 Fifth Ave., New York 3, N.Y. $18 per volume (6 issues).

Informe de Labores (Octubre 1957–Febrero 1961), No. 1. J. F. Velarde, minister of education. Center of Archaeological Researches in Tiwanaku, Box 2325, La Paz, Bolivia.

Investigaciones Agropecuarias, vol. 1, No. 3, Sept.-Dec. 1960. R. Castaneda Paz, Ed. Division de Investigaciones, Instituto Agropecuario Nacional, La Aurora, Guatemala, C.A.

Journal of the Geological Society of India, vol. 1, 1959; vol. 2, 1960. L. Rama Rao, Ed. Geological Society of India, Race Course Rd., Bangalore-1, India. $4 per annum.

Medical Documentation [*Medizinische Dokumentation*], vol. 1, No. 1, Jan. 1961. Deutsche Gesellschaft für Dokumentation. O. Nacke, (21*a*) Ehrsen, Mittelstrasse 29, Schötmar, Germany. Quarterly.

Meteorological & Geoastrophysical Titles, vol. 1, No. 1, Jan. 1961. M. Rigby, Ed. Experimental issue. American Meteorological Society, P.O. Box 1736, Washington 13, D.C. Irregular.

Notas de Arqueologia Boliviana, vol. 1, No. 3, May 1961. National Commission of UNESCO, La Paz, Bolivia.

Quarterly Journal of Crude Drug Research, vol. 1, No. 1, 1961. E. F. Steinmetz, 347 Keizersgracht, Amsterdam, Netherlands. $6.90 per annum.

Radiation Botany, vol. 1, No. 1, Sept. 1961. A. H. Sparrow, Ed.-in-Chief. Pergamon Press, Inc., 122 E. 55 St., New York 22, N.Y. Organizations, $20 per annum; individuals, $10 per annum.

Scientists in the News

Loren C. Eiseley, anthropologist and former provost of the University of Pennsylvania, will receive the 1961 Pierre Lecomte du Noüy award for his book, *The Firmament of Time*. Eiseley, who recently accepted a fellowship at Stanford's Center for Advanced Study in the Behavioral Sciences, will receive the $1000 award on 13 December in New York.

Sumner N. Levine, a former research director for Radio Corporation of America's surface communications division, has been named professor of engineering and chairman of the materials sciences department at the State University of New York.

R. S. Julian Hawes, lecturer in Zoology at the University of Exeter (England), and **John O. Corliss**, professor of zoology at the University of Illinois, are participating in an exchange for the 1961–62 academic year.

Henry A. Murray, of Harvard University, and **Samuel J. Beck**, of the University of Chicago and Northwestern University, have received clinical psychology awards presented at the annual meeting of the American Psychological Association.

Walter H. Hodge, former director of education and research at Longwood Gardens in Kennett Square, Pa., has been appointed consultant in tropical biology in the National Science Foundation's division of biology and medicine.

Eric L. Nelson, former professor in the department of bacteriology at the University of California (Los Angeles), has been named scientific director of Allergan Pharmaceuticals, Inc., in Santa Ana, California.

Jean-Paul Aubert, chief of the isotopes laboratory at the Institut Pasteur in Paris, is spending 3 months as a guest investigator at Cornell University's Hospital for Special Surgery.

Marie A. Jakus, of the Retina Foundation, has been appointed research program coordinator for vision in the National Institute of Neurological Diseases and Blindness extramural programs branch.

Vocal Exchanges between Dolphins

Bottlenose dolphins "talk" to each other with whistles, clicks, and a variety of other noises.

John C. Lilly and Alice M. Miller

Abstract. Observations of the vocal exchanges of bottlenose dolphins under various conditions are presented. Experimental conditions under which isolated emissions from each animal of a pair are separately recorded and in which the distance between the rostrum and the hydrophone is controlled are described. The exchanges consist of vocal alternations (*A*, then *B*, then *A*, and so on), "duets" (*A* plus *B* simultaneously), and long "solos" or "monologues." The emissions exchanged are: (i) whistles alone; (ii) slow click trains alone; (iii) simultaneous whistles and clicks from either or both animals; and (iv) squawks, quacks, blats, and so on, alone or simultaneously with whistles. Any or all of these sounds may occur in a given period. The significant carriers of meaning are to be determined. (Suggestions include various functions of relative amplitudes, absolute and relative frequency, frequency modulations, phase-shift variations, and durations of whistle emissions.) Average and peak amplitudes (at the rostrum) of each class of sound cover at least a 100-decibel range (controlled by the dolphin).

In a previous article (*1*) it was shown that the individual bottlenose dolphin (*Tursiops truncatus*) emits several classes of complex and varied sounds. At least one of these classes (click-creakings) is used in finding food, ranging, and navigating; other classes of sounds may be used for communication between individuals. These latter classes are (i) click trains (not creakings), (ii) whistles, (iii) quacks, blats, and squawks, and (iv) combinations, such as click trains or quacks plus whistles. In this report the first experiments on the possibilities of communication between two dolphins are presented. The techniques and apparatus were those described previously (*1*). Emphasis is placed here on the elicitation of vocal exchanges and on the formal description of these exchanges.

Special experimental conditions are set up (Table 1).

Condition 1. The animals are in solitude, confined and isolated to the extent given in Table 1. This is the "near-zero exchange" state (*2, 3*). The "dullness" and "evenness" of the situation is purposefully maximized. (These conditions are analogous to solitary confinement of a human being in a small box.)

Condition 2. One set of physical constraints is attenuated, and more three-dimensional movement is allowed. (These conditions are analogous to solitary confinement of a human being in a large room.)

Condition 3. Each animal is allowed to hear and reply (in water or air, or in both) to one other unseen, untouched, untasted dolphin (Fig. 1); the dolphin-to-hydrophone distance is controlled, and vocal emissions from the two animals are separated in the recordings. A hydrophone is placed near the rostrum of each dolphin. The animal is so held that it cannot move its head more than a few inches from the hydrophone. The water space is so shallow (10 to 15 in.), so narrow (15 in.), and so short (slightly over one body length) that the animals cannot swim. Each one rests on the bottom most of the time unless it is disturbed by the presence or intervention of a human being.

Condition 4. The animals are no longer confined to the extent of "enforced resting," and each animal has the option of swimming. The distance between the animal and the hydrophone is controlled to a lesser degree than in condition 3 but is still limited to a maximum distance of a few feet. Play with floating "toys" is allowed.

Condition 5. Free bodily contact, biting, mutual play with "toys," racing, courting, mating, stealing and giving food, and so on are all allowed. The animal-to-hydrophone distance is not controlled, and there is some confusion between emissions from one animal and those from the other. After a period of study and observation, the individual emitting whistles, blats, or quacks, can be identified, but identification is less easy in the case of clicking.

Condition 6. Human beings are present and "intervene" through feeding, "rewarding," "punishing," operant-conditioning (especially in production of specific kinds of emissions), play, vocal interspecies "exchanges," transporting, direct brain stimulation, and other measures.

Condition 7. In the oceanaria, captive colonies can be observed. To date, no experiments have been undertaken to study possible exchanges between individuals in such colonies. (Such experiments have been proposed as possible controls for the experiments described here; there are many technical difficulties, such as that of identifying the vocal emissions of specific individuals.)

Condition 8. At sea, the difficulties of experimenting with wild animals and studying their exchanges are increased by the difficulties of finding and staying near the animals for a significantly long period of time. To determine the effects of capture and of captivity on the vocalizations, control experiments should eventually be carried out at sea, with the dolphins in their most free state.

Results

From the standpoint of measurement of physical acoustical quantities, conditions 1 and 3 give the best results; condition 3 gives the best physical recordings of exchanges. From the standpoint of the health and vigor of the animals in captivity, conditions 5 and 6 are best and give the greatest variety of vocalizations. We have a few data for condition 7 but none for condition 8. Most of the results given here are for conditions 3 and 4.

In conditions of solitude the animals' vocal behavior is different from their

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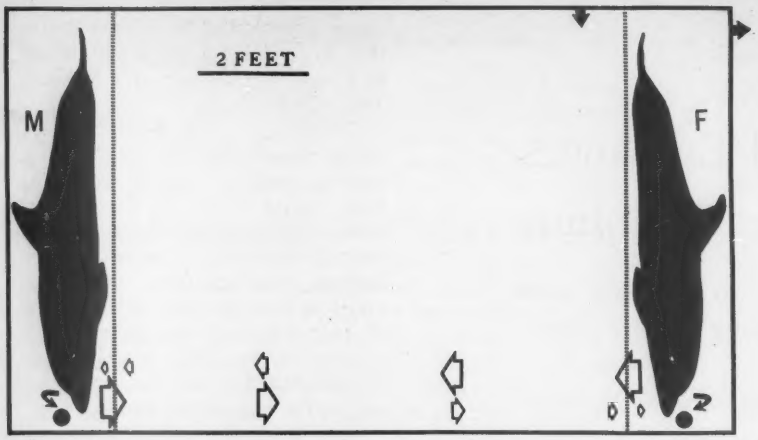

Fig. 1. Configuration for recording vocal exchanges between a pair of isolated and confined dolphins. The animals are resting on the bottom and are shown in lateral elevation, the male (*M*) from his left side, the female (*F*) from her right. (Dotted line) Foam-covered barrier preventing the dolphin from entering the rest of the pool; (black rectangle) inner walls of the salt-water pool; (open arrows, decreasing in size) acoustic-energy transfer from the source-dolphin to the sink-dolphin; (curved solid arrows) energy received by the hydrophone from the dolphin nearest it (attenuated signals are received from the far dolphin); (straight solid arrows) water inflow and outflow. Spoor may possibly be transferred from *M* to *F*; however, the flow of water is greatly impeded by the barriers, so that any exchanges of spoor that may occur probably have little value as signals. Other configurations eliminate spoor-trace clues completely, since no water can move from one dolphin to the other.

Table 1. The most frequent forms of vocalization and vocal exchanges (one and two dolphins). This classification applies best to newly captured animals. After several weeks unpredictable, complex vocalizations appear that are inconsistent with the classification given here.

Condition	Vocal emission (initial or response)	
	Dolphin A	Dolphin B
1. One in solitude, confined*, isolated†, (near-zero exchange)	Whistles and clicks	No response
2. One in solitude, free-swimming‡ (objects-and-background-exchange only)	Whistles, clicks, creakings §	No response
3. Pair, confined, isolated, limited to acoustic exchange path, intraspecies only	Whistles; clicks and/or whistles; clicks	Whistles; clicks and/or whistles; clicks
4. Free-swimming pair, isolated, limited to intraspecies acoustic exchange	Whistles; clicks and/or whistles; clicks; creakings §	Whistles; clicks and/or whistles; clicks (see *3*)
5. Free-swimming pair, free body contact, free acoustic and mating exchanges of all kinds, interspecies isolation ||	Whistles; clicks and/or whistles; clicks; creakings §; quacks, squawks, blats, etc., with or without whistles.	Whistles; clicks and/or whistles; clicks (see *3*); whistles; clicks or quacks, etc., with or without whistles
6. Condition 1, 2, 3, 4, or 5 plus presence or intervention of human being	Same exchanges as in 5 with increase in quacks, etc.; airborne sounds suddenly increase in frequency of occurrence and in amplitude	Same exchanges as in 5 with increase in quacks, etc.; airborne sounds suddenly increase in frequency of occurrence and in amplitude
7. Confined in oceanaria in colony	Not yet examined experimentally	Not yet examined experimentally
8. Free-swimming, unisolated, unconfined in the sea in colony	Not yet examined experimentally	Not yet examined experimentally

* Confined in a box 7½ ft by 15 in. in water 10 to 15 in. deep. † Separated by a barrier to prevent bodily contact with another dolphin or with human beings. ‡ Swimming in one of three pools with, respectively, (i) rough rock sides, 70 by 20 ft, with water up to 12 ft deep; (ii) vinyl sides and bottom 10 by 8 ft, water 22 in. deep; (iii) Fiberglas, smooth sides and bottom 9 by 7½ ft, water up to 30 in. deep. § Creakings do not occur as responses to another dolphin's vocalizations but do occur during feeding, navigation in murky water for novel objects, and so on—that is, as "sonar" for recognition and ranging. || No other species of animals entered or were near the pool, especially no human beings.

vocal behavior when they are in pairs. When they are maintained under condition 1 for a few hours a day (the condition of near-zero exchange), there are usually no creakings. The slow click trains gradually decrease and finally cease. Whistles become less and less frequent over a period of days to weeks when there is a continued lack of "response" from the environment and from other animals, including man. To keep the dolphins healthy, exposure to condition 1 must be limited to short periods.

In condition 2 creakings occur as needed for food finding, exploring new objects, and navigating in muddy water or at night. Whistles and slow click trains gradually cease in a few days or weeks; they are elicited immediately by (i) presentation of the spoor of other dolphins in the water; (ii) visual or acoustic stimuli from another dolphin; (iii) human stimuli of various sorts; or (iv) presentation of toys or novel objects. In other words, a change to conditions 3, 4, 5, 6, or 7 increases the rate of occurrence of vocalizations.

Under conditions 3, 4, or 5, where the dolphins are in pairs, spontaneous vocalizations (Table 1) occur fairly frequently, in bursts lasting from a few seconds to many minutes. In a typical 24-hour day there is a total of at least 4 hours of vocalization, and on many days there is more than this. Under condition 5 (with freedom to swim, to make body contacts, and to mate), a male and a female emit various sounds steadily for periods up to 20 or more minutes, concurrently with play, courtship, and mating behavior.

Under conditions 3 and 4, where members of a pair are in acoustic and vocal contact, definite vocal "exchanges" are demonstrable (Fig. 2). These exchanges are briefer and rarer than the vocalizations that occur under condition 5 (body contact). A "monologue" or a "solo" by one or the other animal may precede, follow, or be unrelated to, an exchange, in the same few minutes; most monologues, however, occur in a close time relation to an exchange. These monologues differ from those of the same animal in solitude (see Table 1, conditions 1 and 2): they are more frequent and more varied in amplitude and frequency.

As shown in Table 1, when the dolphins are in pairs (conditions 3, 4, and 5), the two animals produce alternating emissions (Fig. 2). Rare interruptions of one by the other, or "overlaps," do

occur. A special phenomenon, called a "duet" (Fig. 2: *F*4 and *M*10; *F*5 and *M*11), also occurs: the two animals whistle simultaneously, sometimes matching frequencies and time-patterns so exactly that the relatively low-frequency difference between their simultaneous whistles can be heard.

Alternations without interruptions, overlaps, or duets are the most frequent exchanges. Such alternations consist of whistles or slow click trains, or both (Table 1 and Figs. 2 and 3).

If two dolphins are transferred from condition 3 (confined and isolated with only an acoustic path between them) to condition 4 (free to swim but with no body contact), they make creaking sounds. The creaking can be related to detection, ranging, and recognition of novel objects, to finding food, to pursuit games with a toy, or to navigation in the dark or murkiness to avoid rough walls or other obstacles (*1*, *3*).

If a dolphin is allowed to touch the body of another dolphin (Table 1, condition 5), it makes another set of sounds —squawks, quacks, blats, barks, and so on—both under water and in the air. [Graphic results of analyses of some such individual sounds are shown in the previous paper (*1*).] If a human intervenes with one of a pair of dolphins limited to acoustic exchange (thus changing condition 3 to condition 6), the dolphin barks, squawks, and quacks, apparently at the human, and it may whistle simultaneously every so often, apparently in exchange with the other dolphin. When two dolphins are swimming freely together (condition 5), they exchange such complex mixtures of sounds, but deciding which dolphin emits which sounds is extremely difficult.

After several weeks in captivity in shallow water (18 to 30 inches), a dolphin begins to emit each and every class of sounds in air, including clicks and whistles in addition to quacks.

In Fig. 2 are shown some results obtained in studies made under condition 3—the best condition for controlling and distinguishing the underwater vocal emissions of the dolphins. The upper trace is that of the female dolphin *F* of Fig. 1; the lower trace, that of the male *M* of Fig. 1. This particular exchange opens with the male's slow click train, followed by four whistles (Fig. 2, *M*1, 2, 3, and 4). During whistle *M*1, the male stops clicking shortly after the female begins to click, and the female maintains the train during whistles *M*1,

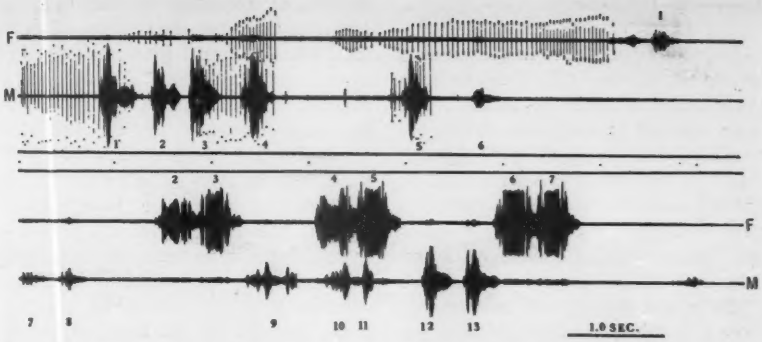

Fig. 2. A graphic record of a vocal exchange between two dolphins. (Top trace in each pair) Emissions of the female (*F*); (bottom trace in each pair) emissions of the male (*M*). The upper pair of traces shows a click-and-whistle exchange; the lower pair, a continuation of the same record without the clicks. (Dots between pairs of traces) Seconds of elapsed time; elapsed time for the whole record, 15 seconds. For reproduction, the peaks of the clicks of the female were marked with black dashes; the tips of those of the male, with black dots. Whistles are numbered in sequence for each animal. Other disturbances in the base line are, in most cases, water noises (see text).

2, 3, and 4. During *M*3, the male starts clicking and continues to click and to whistle (*M*4) throughout the rest of the female's click train. He keeps his click train carefully out of step with hers, and stops his when she stops hers. The female starts clicking again before his whistle *M*5; the male joins in with a few clicks, whistles once (*M*5), and stops clicking. The female continues her clicks for a total interval of 3 seconds. The male whistles once again, faintly (*M*6). The female moves her head (water noises appear at the end of the train) and whistles faintly (*F*1). He answers with two faint whistles (*M*7 and 8). She suddenly whistles loudly twice (*F*2 and 3); he replies with a long single whistle of medium intensity (*M*9). She responds with whistles of high intensity (*F*4 and 5), and he joins her (*M*10 and 11) in a precise "duet," matching her time pattern, and goes on to "reply" more loudly with two whistles (*M*12 and 13). She answers loudly (*F*6 and 7), and both become silent.

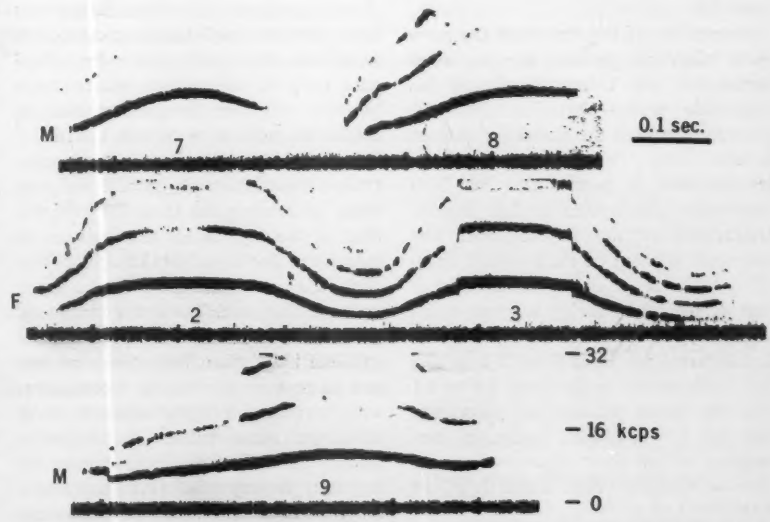

Fig. 3. Sonograms of a portion of an exchange between two dolphins. (*M*) Emissions of the male; (*F*), of the female. Emissions are numbered to correspond to the numbering of the amplitude trace in Fig. 2. The fundamental (*f*) and the first two overtones (*2f* and *3f*) may be seen on these sonograms. Additional sonograms with twice this frequency scale show that energy in the 3rd, 4th, and 5th overtones decreases rapidly as compared to that of the fundamental and the first two overtones. There was some enhancement of the higher frequencies in recording the sonograms (*6*).

Individual Differences

Inspection of these amplitude-time graphs shows some differences between the whistles of these two animals. The male tends to become silent briefly between his pairs of whistles (*M*1 through 8 and 12 and 13). The female tends to "fill in" between what correspond to his pairs of whistles with sound. He builds his average intensity to a fast peak and drops it to a lower level in the last half of the record. A male may have one or more fast notches and fast peaks in his record. A female also does this (other records); she may often start at a lower level, rise suddenly to a higher one, and drop back to the lower one (Fig. 2, *F*6 and 7). She also may have one or more deep fast notches and peaks in the amplitude record.

In analyzing these sounds for their frequency, these amplitude variations can be correlated with the frequencies emitted. Figure 3 shows sonograms of frequency versus time for emissions *M*7 and 8 (top traces), *F*2 and 3 (middle traces), and *M*9 (bottom traces). In general all of the time pattern of the fundamental (frequency *f*) is shown; the second harmonic (2*f*) and third harmonic (3*f*) sometimes do not show because of their low intensity. At other times all the harmonics up to the sixth (6*f*) have sufficient intensity to be recorded. (Almost all of the frequencies are integral multiples of the fundamental.)

Inspection of the traces of the male show that, in general, the recorded harmonics are enhanced during his amplitude peaks—that is, when the amplitude is high the harmonic content is high (*M*8, *M*9). The traces of the female show in general that her high amplitudes correspond to her highest frequencies of the fundamental. The harmonic content of the female's emissions tends to be more constant than that of the male during a given emission. The frequencies covered by his fundamental are from 6 to 15 kcy/sec; her fundamental varies from 3.5 to 11 kcy/sec. Some of her low-frequency and her low-amplitude emissions correspond to his short silences between pairs of whistles (Figs. 2 and 3, *F*2 to *F*3).

The separation of the emissions of whistles into countable integral units is based on measurements of occurrences and durations and on graphical records of isolated single whistles, on repetitions of similar (but not necessarily identical) patterns of frequency variation in pairs and triplets, and on the qualities of their total effect as heard (slowed down) by experienced observers. When the female whistles, she emphasizes the relatively flat, high-frequency portion and deemphasizes the low-frequency "slump," somewhat the way some people fill in between words with a low-intensity "aaaah." (Listening to records obviously does not give us the same acoustical experience that the dolphins have; the dolphins have a much wider hearing range than we do and they may have special resonators in the hearing side as well as on the transmitting side which may make the hearing experience of sounds an entirely different kind of experience for them than for us.)

Usually, but not always, the duration of the whistles is of the order of 0.2 to 0.4 second (see Fig. 2). Under special conditions yet to be thoroughly determined, extremely short (0.1 second) or extremely long (2 to 3 seconds) whistles, or both, occur. Most whistle transmissions are in the middle range.

Trains of clicks cover the full range of duration of the whistles and sometimes continue as long as 15 seconds without pause. The most frequently observed durations for click trains are close to those of the longer whistles (0.5 to 1 second).

The amplitudes of the middle-frequency components (less than 40 kcy/sec) of each click are varied by the dolphin in systematic ways. Sonograms and detailed high-speed oscillograph recordings show each click to be a complex train of sine waves whose components vary in frequency and in amplitude with time within the train. From click to click there is more controlled variation in the middle and low range of frequencies (1 to 20 kcy/sec) than in the high range (20 kcy/sec to apparatus limits at 64 kcy/sec). The clicks are not "white noise" in the range below 20 kcy/sec. The lower-frequency portion of the train lasts up to 5 msec and can have mean frequencies as low and as high as the whistle frequencies, with variations ranging from ½ to 2 times the mean value. The high-frequency portion of the train (above 20 kcy/sec) is very brief (0.1 msec) and may, with certain kinds of frequency analyzers, appear to be white noise (*4*).

If one listens to slowed tape recordings (slowed to 1/16 of normal speed) the complex tonal variations can be perceived within each click, from one click to the next, and from animal to animal. The clicks of "creakings" (Table 1) are higher pitched, shorter, and "harder-sounding" than those of exchanges (*4*). The "sonar" click is usually one of high frequency; the exchange click, one of lower frequency.

Conclusion

In this report (*5*) we have presented something of what dolphins transmit in their exchanges—signals plus noise. A few tentative, simple "meanings" have been found ("distress," "attention," "irritation," and so on); however, most of the exchanges are not yet understood.

Note added in proof: Since this report was submitted we found that dolphins can emit ultrasonic clicks independently of sonic clicks and vice versa.

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5. This research has received support from the Air Force Office of Scientific Research, the Coyle Foundation, the U.S. Department of Defense, the National Institute of Mental Health, the National Institute of Neurological Diseases and Blindness, and the Office of Naval Research. We thank K. N. Stevens of the Massachusetts Institute of Technology for the use of a Kay Sonograph, J. C. Steinberg of the University of Miami for the use of a hydrophone set, and Herbert Gentry of Orlando, Fla., for the use of a Precision Company wide pass-band tape recorder.

6. The sonograms were made with a Kay Electric Company Sonograph.

13 April 1961

Cutaneous Molt Induced by Calciphylaxis in the Rat

Abstract. A molt, conducive to the loss and subsequent replacement of all cutaneous layers, can be induced by topical "calciphylaxis" in the rat. This is accomplished by sensitization with dihydrotachysterol followed by challenge with egg white or ferric dextran.

Calciphylaxis is a condition of induced systemic hypersensitivity in which, during a "critical period" after sensitization by a systemic calcifying factor (for example, vitamin-D compounds, parathyroid hormone, sodium sulfathiazole), treatment with certain challengers (for example, metallic salts,

albumen) causes an acute local calcification, followed by inflammation and sclerosis. The term was coined in analogy with such designations as "anaphylaxis" or "tachyphylaxis" that likewise refer to induced systemic alterations in the body's responsiveness to certain challenging agents. Apparently, calciphylaxis is a fundamentally adaptive (phylactic) response, that leads to defensive inflammation and sclerosis, through the selective deposition of calcium in the challenged area. However, like many other basically defensive reactions (for example, serologic immunity), it can also become the cause of morbid lesions (*1*, *2*).

The skin is particularly predisposed to the induction of massive calcium deposition through topical calciphylaxis. We have recently developed a technique in which, following sensitization by dihydrotachysterol (DHT), a single subcutaneous injection of egg white or a ferric dextran (Fe-Dex) causes acute massive petrification with subsequent exuviation of all cutaneous layers in the rat.

Sixty female Holtzman rats with a mean initial body weight of 98 g (range, 95 to 100 g) were subdivided into five equal groups and treated as follows: group 1, DHT; group 2, egg white; group 3, Fe-Dex; group 4, egg white plus DHT; and group 5, Fe-Dex plus DHT.

Dihydrotachysterol (*3*) was given on the first day at the dose of 1 mg in 0.5 ml of corn oil by a stomach tube once. Egg white (50-percent aqueous solution of domestic fowl albumen) and ferric dextran (*4*) (diluted with water to contain 10 mg of metallic iron per 10 ml) were both administered once on the second day, at a dose of 10 ml, by subcutaneous infiltration of the entire body surface, except the head, anogenital region, and extremities, in order not to interfere with food ingestion, excretion, and locomotion. The calcific nature of the cutaneous deposits was verified histochemically (by means of the von Kóssa technique).

No cutaneous lesions were produced by treatment with DHT alone, while Fe-Dex and egg white alone produced only a transitory edema which subsided within about 48 hours. By contrast, the rats sensitized with DHT and subsequently challenged by the subcutaneous injection of either egg white or Fe-Dex developed a massive cutaneous calcification which transformed the entire challenged skin area into a hard exoskeleton-like tight-fitting shield. In the course of the next 3 weeks the calcified skin began to detach itself along its borders. During the fourth week large cracks appeared in this "carapace," usually along its ventral surface, while a fine lanugo-bearing new skin was formed underneath. A few days later, the old calcified, and still hair-bearing, skin was cast off and the rats crept out of their exuviae with a new cutaneous covering (Fig. 1).

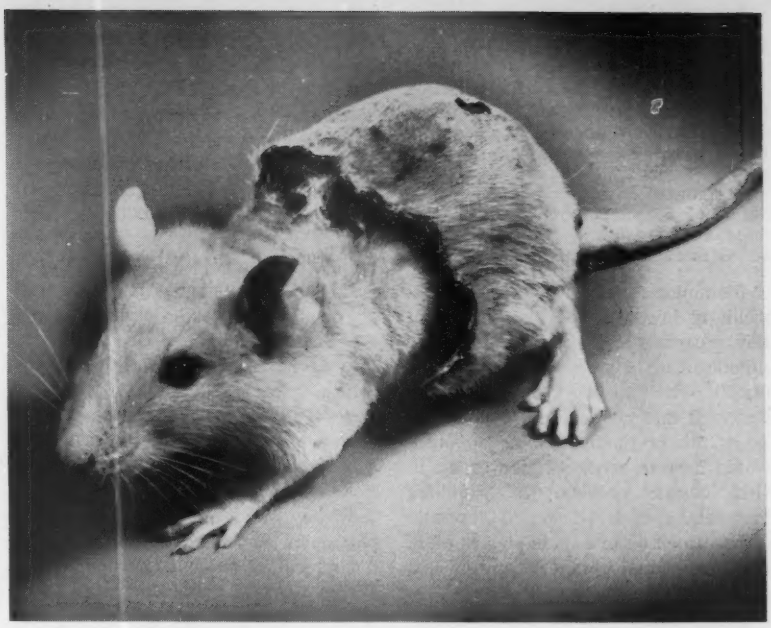

Fig. 1. Rat 3 weeks after sensitization with DHT followed by challenge with egg white. The petrified old skin is almost fully detached and ready to be cast off. Both the old and the new skin are hair bearing. Curiously, the animal does not appear to be particularly damaged by this extensive molt.

During the first few days, while cutaneous calcium deposition was in progress, the skin appeared to be painful to touch, but after the first week the animals showed no evidence of discomfort and rapidly gained in weight. Interestingly, several of the rats which, owing to previous accidental injuries, happened to have scars, cast these off together with their old skin and developed no comparable lesions in the newly formed derma.

In general, the cutaneous tissue, like the skeletal connective tissue, possesses a particular ability to store calcium and other metals, but only a few animal species form a shield-like calcified carapace or exoskeleton (for example, lobster, armadillo). The biochemical mechanisms responsible for the physiologic development and periodic exuviation of calcified skin structures is not known. It remains to be seen whether there is any relationship between these normally occurring cutaneous changes and calciphylaxis. It is noteworthy, however, that even treatment with normal body constituents can produce cutaneous calcinosis with subsequent shedding of the affected skin. This was accomplished, for example, by treatment with parathyroid hormone as a sensitizer and iron ($FeCl_3$) as a challenger in the rat (*2*, *5*).

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4. Ferric dextran (Imferon, Benger Labs, Toronto, Canada).
5. This work was supported by the Gustavus and Louise Pfeiffer Research Foundation and by the Office of the Surgeon General, U.S. Army Medical and Research Command, contract No. DA-49-193-MD-2039.

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† Fellow of the Life Insurance Medical Research Fund.

24 July 1961

In vitro Culture of Pyrodinium

Abstract. Water from Puerto Rico's Phosphorescent Bay, when enriched with vitamin B_{12}, thiamine, biotin, yeast autolysate, and bay-mud acid hydrolysate, has been found to support vigorous in vitro growth of the luminescent dinoflagellate *Pyrodinium bahamense*. Cultures of *Pyrodinium* are being maintained through serial passage.

Bioluminescence displayed so spectacularly in waters of Phosphorescent Bay, Puerto Rico, is produced by the dinoflagellate *Pyrodinium bahamense* (*1*, *2*). The late E. Newton Harvey lamented that chemiluminescence studies of this brilliantly flashing organism would have to await solution of the in vitro culture problem (*2*). Fulfilling this desideratum, we report the successful isolation and maintenance of *P. bahamense* under both the axenic and bacterized conditions.

From water samples collected during midday hours from depths to 2 meters near the center of Phosphorescent Bay, some 8000 *Pyrodinium* cells were miropipetted to petri dishes containing Seitz-filtered bay water. From these, groups of 300 to 600 cells were transferred to the first well of a nine-well depression plate. The most vigorously swimming cells were then micropipetted successively from well to well, 2 ml of sterile bay water having previously been added to each well. This technique had previously been found effective in lessening or eliminating bacterial contamination during isolation procedures with other motile single-cell algae and protozoa (*3*). From the final well, groups of 1 to 100 cells were transferred to 20-ml plastic-capped culture tubes containing 10 ml of sterile bay water.

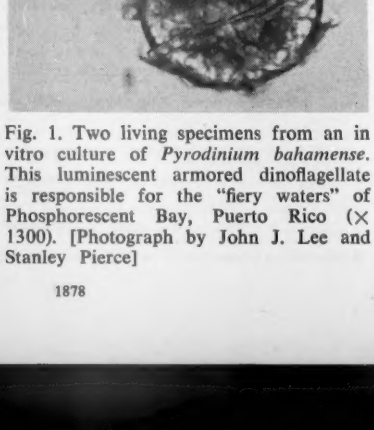

Fig. 1. Two living specimens from an in vitro culture of *Pyrodinium bahamense*. This luminescent armored dinoflagellate is responsible for the "fiery waters" of Phosphorescent Bay, Puerto Rico (× 1300). [Photograph by John J. Lee and Stanley Pierce]

Guided by our earlier experience in isolating and culturing zooxanthellae (*3*), we tested some 2000 variations and permutations of enrichment and antibiotic materials before a suitable formula was achieved for support of *Pyrodinium* growth. Optimal growth-supporting media comprised filtered bay water, 90 percent; B_{12}, 0.1 μg/100 ml; thiamine HCl, 1.0 mg/100 ml; biotin, 0.1 μg/100 ml; yeast autolysate, 0.0001 percent; acid hydrolyzed bay-mud extract, 1 to 10 ml/100 ml. Enrichment materials were used in conjunction with an antibiotic solution containing K penicillin G, 1.0 percent; novobiocin, 0.001 percent; polymyxin B, 0.001 percent; Vancomycin, 0.1 percent; Ilotycin, 0.1 percent; and Tylosine, 0.1 percent (*3*). The antibiotic mix was added to culture tubes over a concentration range of 0.05 to 2.0 ml per 10 ml of culture media. Previously derived synthetic media (*3*) failed to support *Pyrodinium* growth. Before inoculation, medium was autoclaved at 5 lb pressure for 2 hours.

Culture tubes were maintained at 24° to 28°C in a light-dark cabinet (14 hours light; 10 hours dark), with light supplied by three 40-watt white cool fluorescent lamps and one 20-watt tungsten bulb.

Within 20 days after inoculation, abundant cell division was observed. Transfers to fresh media are now made routinely at 30-day intervals. Such cultures have gone through multiple serial passage, with no apparent loss of motility or reproductive vigor. Two culture lines are currently in an axenic or bacteria-free state; three lines, although bacterized, support a vigorously proliferating population of *P. bahamense*.

Luminescence appears to be greatest when observed 4 to 6 hours after the beginning of the daily dark period. A sharp tap on the culture vessel invariably results in bright luminescence of the entire liquid contents, with a myriad of conspicuous starlike flashes. The luminosity pattern of *P. bahamense* appears to resemble that observed by Sweeney and Hastings for *Gonyaulax polyedra* (*4*; *5*).

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3 August 1961

Effect of Enzymes on Partially Purified Japanese B Encephalitis and Related Arbor Viruses

Abstract. Japanese B encephalitis and some other arbor viruses were partially purified by cellulose column chromatography or by fluorocarbon deproteinization and tested for sensitivity to enzymes. Infectivity decreased markedly when the viruses were mixed with trypsin or pancreatic lipase at 37°C. The enzymes also impair the immunogenicity of the virus in rabbits. Poliovirus is resistant to the enzymes.

The effect of enzymes on viruses is different from one enzyme-virus combination to another (*1*). Reduction of the infectivity of arbor (*ar*thropod-*bor*ne) viruses by proteolytic enzymes has been described (*2*). The virus materials used in these previous studies were relatively crude. We report experiments in which arbor viruses grown in tissue cultures and then partially purified were examined for sensitivity to enzymes.

The viruses used were Japanese B encephalitis, strain G1; dengue type 1, Mochizuki strain; yellow fever, strain 17 D; and Western equine encephalitis, Rockefeller Institute stock strain. The viruses were grown in trypsinized hamster-kidney cell cultures (*3*). Poliovirus, strain MEF-1, was grown in

HeLa cell cultures for comparison. Culture fluid harvested from the infected cultures, showing characteristic cellular degeneration, was centrifuged at 3000 rev/min for 15 minutes to remove crude debris masses. The supernatant fluid, undiluted or diluted with tissue-culture fluid, was loaded onto a column containing ECTEOLA-cellulose and eluted with 0.07*M* phosphate buffer solution (*p*H 7.2) (*4*). Some supernatant fluid was treated with fluorocarbon (*5*). By either procedure practically 100 percent of the virus is recovered, and more than 90 percent of the nitrogen contained in the original virus materials is removed. Nitrogen contents of purified virus suspensions, as measured by the micro-Kjeldahl method, ranged mainly from 0.1 to 0.2 mg/ml.

The enzymes used were trypsin (crystalline) (*6*), papain (powdered) (*7*), bacterial proteinase (crystalline) (*8*), pancreatic lipase (powdered) (*6*), bacterial lipase (liquid) (*8*), wheat-germ lipase (powdered), α-amylase (crystalline), ribonuclease (crystalline), and lysozyme (crystalline) (*6*). The enzymes, except for bacterial lipase, were dissolved in sterile phosphate buffer solution (*p*H 7.2) at a final concentration of 0.125 percent and tested without further sterilization. Bacterial lipase was diluted with phosphate buffer solution (*p*H 6.0) to a final concentration of 125 units per milliliter; one unit decomposes 1 percent of 2 g of olive oil after exposure of 2½ hours at *p*H 5.6 and temperature of 30°C.

The partially purified viruses were mixed with enzymes, incubated at 37°C (except for bacterial lipase, which was incubated at 30°C) for 1 to 2 hours, diluted decimally with Hanks' salt solution, and titrated for active virus content by inoculation into either mice or tissue culture tubes. The LD_{50} or $TCID_{50}$ values were calculated by the method of Reed and Muench (*9*). In controls, phosphate buffer solution was used in place of enzyme solution.

The results from several experiments are summarized in Table 1. The infectivity of these arbor viruses decreases markedly, or is lost completely, on exposure to trypsin or pancreatic lipase. Bacterial proteinase or lipase also reduce (though less than trypsin or pancreatic lipase do) the infectivity of purified Japanese B encephalitis virus, whereas wheat-germ lipase, α-amylase, ribonuclease, and lysozyme have little effect. When purified Japanese B encephalitis virus is treated with trypsin for 1 hour at 37°C and then exposed to ribonuclease for 2 hours, there is no reduction in viral infectivity.

Table 1. The effect of various enzymes on the infectivity of partially purified viruses. For Western equine encephalitis and Japanese B encephalitis the unit of virus titer was mouse intracerebral LD_{50} (log) per 0.02 ml; for dengue, yellow fever, and poliomyelitis, it was $TCID_{50}$ (log) per 0.2 ml plus 1.8 ml of culture medium.

Enzyme	Viral infectivity at times indicated				
	Enzyme-treated			Control	
	Hr 0	Hr 1	Hr 2	Hr 0	Hr 2
Western equine encephalitis					
Trypsin	6.50	4.50	1.50	6.50	6.50
Lipase	6.50	3.00	0.50	6.50	6.50
Japanese B encephalitis					
Trypsin	5.00	4.75	0.50	5.25	4.50
Papain	3.50		2.50	3.25	3.25
Proteinase (*B*)*	4.50	4.25	3.25	4.75	4.75
Lipase (*P*)†	3.25	0‡	0	2.75	2.50
Lipase (*B*)*	4.75	3.50	3.25	4.75	4.75
Lipase (*W*)§	4.75		4.50	4.75	4.50
α-Amylase	4.50		4.75	4.75	4.50
Ribonuclease	3.75		3.75	4.25	4.00
Lysozyme	2.75		3.25	2.75	2.50
Dengue					
Trypsin	5.25		0.50	4.75	4.50
Lipase (*P*)†	5.00		2.50	4.75	4.50
Yellow fever					
Trypsin	4.25		1.50	4.25	4.25
Lipase (*P*)†	4.25		1.25	4.25	4.25
Poliomyelitis					
Trypsin	6.75		5.50	6.50	6.50
Lipase (*P*)†	6.25		6.50	6.50	6.50

* *B*, bacterial. † *P*, pancreatic. ‡ No infective virus was detected. § *W*, wheat germ.

One milliliter of the treated or untreated Japanese B enchephalitis virus was injected intravenously into male rabbits three or four times at intervals of about a week. Complement-fixing titers and neutralizing indices were measured. In animals receiving active purified virus, antibodies were produced well and regularly; complement-fixing titers of serum drawn 1 to 2 weeks after the last injection ranged from 1:64 to 1:128. Neutralizing indices ranged from $10^{2.5}$ to $10^{3.0}$. Antibody development in animals inoculated with enzyme-treated virus was significantly lower and more irregular; in some animals no antibody was produced.

The results appear to indicate that trypsin and lipase have an effect on substances controlling the infectivity and immunogenicity of some arbor viruses. Although infective ribonucleic acid can be extracted from tissues infected with arbor viruses (*10*), viral ribonucleic acid in infective (probably mature) virus particles is apparently resistant to ribonuclease.

Partially purified poliovirus is resistant to pancreatic lipase, although it is apparently affected by trypsin to a certain extent. Whether there is a correlation between this differential effect of enzymes and the finding that poliovirus resists ethyl ether whereas arbor viruses are destroyed by it (*11*) may warrant further consideration (*12*).

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Insecticide Content of Diet and Body Fat of Alaskan Natives

Abstract. A study was made of the DDT and DDE content of the diet and body fat of native Alaskans who lived in isolated, primitive areas and had minimal contact with insecticides. No DDT or DDE was detected in any of the native Alaskan foods analyzed with the exception of two white owls, both of which contained low levels of DDE. Eskimos store considerably less DDT and DDE in their body fat than the general population in the United States. These low dietary levels and the resultant low levels in body fat are consistent with previously published data on the relationship between intake and storage of DDT.

Analysis of representative restaurant (*1*) and institutional (*2*) meals has indicated that the average person in the United States consumes 184 to 202 μg of DDT and even smaller amounts of DDE in his daily food. Most of the material is found in animal fats, and only small amounts in vegetables and other constituents of meals. The total dietary intake accounts for most if not all of the DDT and its metabolite DDE stored in people without occupational exposure to the insecticide.

Hayes and his co-workers (*3*) reported that analysis of fat from persons who died before 1942, and, therefore, before the use of DDT, revealed no trace of DDT-like material. By contrast, samples of body fat collected from the general population during 1954–56 contained DDT in an average concentration of 4.9 parts per million (ppm). The same authors found that meatless meals served in a cafeteria catering to meat abstainers contained only about one-fourth as much DDT as meals served in ordinary restaurants. Persons abstaining from meat deposited in their fat only about half as much DDT as people with an ordinary diet. Thus, for that study, the storage of the insecticide was not only proportional to dietary dosage but also proportional to the intake of meat. Although dosage was probably the important variable, the data offered no way of evaluating any contribution that animal fat may make to the absorption and eventual storage of DDT present in the food.

It is, of course, clear that occupational exposure to DDT may lead to storage far greater than that ever reported as the result of ordinary dietary intake. An average concentration of 17.1 ppm was found in the fat of agricultural workers who applied DDT (*3*). A concentration as high as 648 ppm was found in the fat of an asymptomatic worker in a formulating plant (*2*).

Further search has been made for groups of people with minimal occupational, environmental, and dietary contact with DDT. Native Alaskans who live in an isolated, primitive area where there is little or no use of insecticides and who eat food of local origin appeared to be a group that might have minimal DDT exposure and at the same time maximal intake of animal fat. The present paper describes a study of DDT and DDE content of the diet and body fat from these Alaskan natives.

The food samples were collected in the villages of Shungnak, Kotzebue, Gambell, Hooper Bay, and Point Hope. A total of 42 samples of food, representing 31 different items of the Eskimo diet, were analyzed. The foods studied included various fresh and dried fish; fat, oil, or meat from beaver, beluga, caribou, eider duck, moose, oogruk, polar bear, seal, walrus, whale, and white owl; and miscellaneous foods including cranberries, salmonberries, and wild rhubarb. These foods make up the major portion of the diet of the village Eskimos. There are also a limited number of imported food items, including cereals, sugar, bacon, lard, and hydrogenated fat, in the diet of these people.

All analyses for DDT and DDE in both food and body fat were carried out by the modifications of the Schechter-Haller spectrophotometric procedure cited by Hayes *et al.* (*3*).

No DDT or DDE was detected in any of the native foods analyzed, with the exception of two white owls from Point Hope, which contained 1.1 ppm DDE in the meat. The source of exposure of these birds to DDT is unknown. It may be accounted for by their migratory habits. It is also possible that some naturally occurring constituent of food stored by these birds may interfere in this analysis.

Samples of human body fat were obtained through the cooperation of the U.S. Public Health Service Hospital in Anchorage. Single samples from 20 patients were analyzed. The subjects chosen were residents of isolated villages. Fat samples were taken from patients who underwent surgery after a minimal period of hospitalization. Sample meals from this hospital for one day were analyzed and found to contain 184 μg of DDT and 26 μg of DDE. A dish of meatballs and spaghetti contained 111 μg of DDT and represented 60 percent of the daily total residue of this insecticide in the diet. These daily totals for DDT and DDE are similar to those found in representative restaurant and institutional meals in the 48 contiguous states (*1*, *2*).

The DDT and DDE content of the body fat of these native Alaskans is shown in Table 1, along with comparative values obtained for the general population and for meat abstainers by

Table 1. Storage of DDT and DDE in the fat of Alaskan natives (as found in this study) in comparison with the general population of the United States and with abstainers from meat (as found by Hayes *et al.*, *3*).

Value	DDT (ppm)		DDE (ppm)	
	Tissue	Extract*	Tissue	Extract*
	Alaskan natives (20 cases)			
Range	0 to 1.9	0.3 to 2.2	0 to 3.9	2.5 to 5.8
Mean ± S.E.	0.8 ± 0.10	1.4 ± 0.16†	2.0 ± 0.41	3.8 ± 0.31†
	General population (61 cases)			
Range	2 to 12	3 to 22	2 to 13	3 to 25
Mean ± S.E.	4.9 ± 0.35	6.8 ± 0.42	6.1 ± 0.42	8.6 ± 0.52
	Abstainers from meat (16 cases)			
Range	0 to 7	0 to 10	0 to 9	0 to 12
Mean ± S.E.	2.3 ± 0.44	3.5 ± 0.63	3.2 ± 0.63	4.9 ± 0.84

* Carbon tetrachloride extract. † Based on 11 samples only.

Hayes *et al.* (*3*). It is apparent that these Eskimos stored considerably less DDT and DDE than persons in the general population of the United States and somewhat less than meat abstainers. The DDE constituted from 10 to 90 percent and averaged about 73 percent of the total DDT-derived material for the Eskimo. For the general population this percentage was 56 and for meat abstainers, 59. These figures support a view that individuals with a lower degree of exposure to DDT are able to convert DDT to DDE more efficiently. The low storage level is consistent with the low level of the insecticide and its metabolite found in the Eskimo diet in spite of the very high meat content of that diet. The small amount of DDT and DDE that was found in the fat of the native Alaskans is probably accounted for by their limited consumption of imported foods and by their brief intake of hospital food prior to surgery.

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Drug Resistance due to Inbreeding

Abstract. Inbred mice susceptible to audiogenic seizures were found to develop resistance to the protective effects of chlorpromazine and its analogs. It is proposed that the use of such inbred mice provides a unique new tool for studying drug mechanism and drug resistance.

In several earlier reports I have shown that various phenothiazine ataractics exert protection against sound-induced convulsions in mice [audiogenic seizures (*1–3*)]. There are, however, conflicting reports about the degree of protection exerted by these agents (*4*). More recently it was reported that chlorpromazine was totally inactive against convulsions in an inbred strain of Swiss mice (*3*). The present report is an extension of that preliminary report.

The test chamber and sound source were described in an earlier paper (*1*). Essentially, the procedure consists of placing groups of five mice in the test chamber and exposing them to auditory stimulation for 1 minute. The criterion used to measure protection in this study was the occurrence or nonoccurrence of convulsions (clonic and tonic).

The diametrically opposed data obtained with chlorpromazine in noninbred and in inbred albino Swiss mice raise the interesting possibility that development of drug resistance may be incidental to inbreeding (*3*). To investigate this point, careful separation of the various generations of inbred Swiss mice was made, and a systematic bioassay of the effects of chlorpromazine and other agents on each individual generation of inbred Swiss mice was conducted.

The first agent studied under these conditions was chlorpromazine, which had been shown earlier to be a potent antagonist of seizures in noninbred Swiss mice. A constant dose known to be effective in noninbred mice was tested in each separate generation. A summary of the findings is shown in Table 1. The degree of protection exerted by chlorpromazine diminishes from the parental generation to each succeeding generation.

About 91 percent of the P_1 group was protected against convulsions by 10 mg of chlorpromazine. In the F_1 generation, a sharp reduction in protection against convulsions was seen. Only 33.3 percent of the animals were protected. Succeeding generations (F_2, F_3, F_4, and F_5) had protection rates of only 16.3, 7.1, 3.3, and 8.3 percent, respectively. Studies with higher doses (up to 80 mg/kg) did not show any discernible protection.

Control studies of generations F_1, F_2, F_3, F_4, and F_5 showed that these generations exhibited convulsions at a frequency of 90 percent.

Prior to auditory stimulation, all mice used in this research typically exhibited all of the symptoms of chlorpromazine medication: ptosis, heavy sedation, and ataxia. However, auditory stimulation of the "nonprotected" generations resulted in immediate arousal followed by wild running that culminated in convulsions. No mice receiving medication were used for inbreeding purposes.

Table 1. Protective effect of chlorpromazine on various generations of inbred Swiss mice.

Generation	Number convulsed / number tested	Protection (%)
P_1	3/34	91.1
F_1	10/15	33.3
F_2	41/49	16.3
F_3	26/28	7.1
F_4	29/30	3.3
F_5	11/12	8.3
F_{12}	10/10	0.0
F_{13}	10/10	0.0

The response of the mice of generations F_1 to F_5 to the auditory stimulus appeared to be a potentiation of a "fright" response, manifested by frenzied running. On the other hand, the proportion of homozygosity to heterozygosity may influence the "strength" of phenotypic expression and drug effect. In addition, the genes may be linked. These are questions to be settled through future research.

Preliminary studies of chlorpromazine analogs (promazine, perphenazine, prochlorperazine, and trifluoperazine) suggest a similar trend. All of these agents have been reported to be effective antagonists of audiogenic seizures in noninbred Swiss mice. However, as shown in Table 2, inbred mice (generations F_2 to F_5) are not significantly protected by these same agents. Thus, a maximal protection against convulsions of only 20 to 30 percent was obtained with promazine, perphenazine, prochlorperazine, and trifluoperazine in the inbred generations. In contrast to the phenothiazine ataractics, the barbiturate sodium phenobarbital uniformly gave complete protection against convulsions in all inbred generations tested.

Table 2. Protective effect of phenothiazine ataractics and phenobarbital on various generations of inbred Swiss mice.

Number convulsed /number tested			
F_2	F_3	F_4	F_5
	Promazine		
5/5	7/10		
	Perphenazine		
5/5	5/5	5/5	
	Compazine		
	8/10	8/10	
	Stelazine		
4/5	4/5	4/5	5/5
	Phenobarbital		
0/10	0/10	0/10	0/10

It has been demonstrated that each succeeding generation of inbred mice showed lowered response to the protective effects of chlorpromazine. This finding suggests that genetic characteristics of sensitivity to the effects of chlorpromazine and its analogs are somehow deleted or lost during the course of inbreeding by brother-sister matings. Although this finding is still of a preliminary nature, it may prove possible to investigate neurochemical mechanisms of action of chlorpromazine and its analogs by utilizing differences that may exist between inbred and noninbred mice of the Swiss strain. Thus, it may be possible to find enzymatic intermediates that are deleted by inbreeding and that are essential for normal drug activity. Studies of this nature could lead to a new approach in uncovering key mechanisms of drug action and drug resistance (*5*).

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Effect of Meprobamate on the Multiplication of Brucella abortus in Monocytes

Abstract. Peritoneal mononuclear phagocytes (monocytes) obtained from guinea pigs that had been treated with meprobamate do not support, in vitro, the intracellular growth of smooth *Brucella abortus* that is characteristic of monocytes from untreated animals. This modification of intracellular events appears to be due to an indirect action of the drug, since meprobamate does not produce any effects following direct exposure of monocytes or bacteria to the drug in vitro. Furthermore, the brucellacidal activity of serum from animals exposed to meprobamate is not increased. An interaction between monocytes and a component in the serum of animals exposed to meprobamate is required for the altered intracellular events.

Virulent organisms of *Brucella abortus* will multiply within peritoneal mononuclear phagocytes (monocytes) of susceptible animals when these cells are maintained in vitro (*1*); in contrast, monocytes from innately resistant (*2*), or from brucella-infected (*3*), animals support little, if any, intracellular multiplication. In various efforts to find other conditions that might modify intracellular growth in vitro, we found that adrenocortical and gonadal steroids and bacterial endotoxins, when introduced either directly into the tissue culture system or injected into guinea pigs prior to the collection of monocytes, did not affect intracellular growth (*4*). In a recent study of certain tranquilizers, which in addition to their well-known influence on the central nervous system also have been reported to affect antibody formation (*5*), resistance to bacterial pathogens (*6*), and carbon clearance (*7*), meprobamate had pronounced effects when it was administered to monocyte donors.

Our procedures for harvesting and maintaining monocytes for studies in vitro have been described on several prior occasions (*1, 3, 4*). Briefly, monocytes were collected 48 hours after intraperitoneal stimulation with saline, introduced into Porter flasks containing 30 percent autologous serum in Hanks' balanced salt solution, and were then exposed to brucellae. Extracellular brucellae were subsequently eliminated by replacing the initial medium with serum-Hanks' solution containing streptomycin (10 μg/ml). Intracellular multiplication was assessed periodically by examining the bacterial contents of individual stained macrophages, and by viable counts on the yields from disrupted monocyte populations. Meprobamate was administered either subcutaneously into the flank, or orally, as five doses (of 50 to 100 mg) over a 60-hour period immediately prior to the collection of monocytes. Control animals received distilled water instead of meprobamate.

When monocyte cultures were initiated with cells from guinea pigs given meprobamate orally, ingestion was not affected but the intracellular multiplication of virulent brucellae was less in monocytes from meprobamate-treated animals than in monocytes from water-fed controls (Table 1). Similar results were obtained after subcutaneous injection of meprobamate. Since meprobamate has little tranquilizing effect when given by the subcutaneous route, it would seem that the effects observed are independent of the tranquilizing action.

Table 1. Distribution of brucellae within individual monocytes, and yields of viable brucellae per flask, in cultures initiated with monocytes from guinea pigs exposed to meprobamate (five 100-mg doses over 60 hours) or water. Figures not in parentheses are from experiments in which the drug or water was given orally; figures in parentheses are from experiments involving subcutaneous injections of drug or water.

Age of monocyte cultures*	Monocyte donors treated with	Percentage of monocytes containing indicated number of brucellae†				Viable count per flask‡ ($\times 10^6$)
		0	1–10	11–20	>20	
2	Water	36 (48)	64 (52)	0 (0)	0 (0)	1.41 (0.90)
2	Meprobamate	34 (45)	66 (55)	0 (0)	0 (0)	0.96 (1.20)
24	Water	17 (37)	60 (54)	20 (9)	3 (0)	1.60 (0.95)
24	Meprobamate	42 (44)	54 (53)	3 (3)	1 (0)	1.25 (0.50)
48	Water	10 (17)	22 (38)	5 (7)	63 (38)	35.2 (40.0)
48	Meprobamate	36 (46)	60 (43)	0 (5)	4 (6)	7.45 (1.9)

* In hours following initiation. † Average of counts on two coverslips; 50 monocytes were examined per coverslip. ‡ Average of duplicate counts on each of two flasks.

Because meprobamate given orally in these amounts did produce pronounced tranquilization, the effect of the drug on the monocytes might have been a consequence of starvation. However, complete deprivation of food and water for 72 hours did not lead to inhibition of intracellular growth. The drug was not directly bactericidal for brucellae, and sera from meprobamate-treated animals had no more brucellacidal activity than sera collected from the same animals prior to treatment. Further, the addition of meprobamate directly to monocyte cultures did not affect intracellular multiplication of brucellae. Therefore, the effects obtained with monocytes from treated animals must be regarded as the result of an indirect mode of action, possibly involving a metabolite of meprobamate produced in vivo.

To determine whether the in vivo changes that lead to altered properties of the monocytes affected primarily the cells or the serum, the following experiment was performed. Guinea pigs were bled and the serum was stored for later testing. One week later the animals were treated with meprobamate by the oral route, and after termination of treatment another sample of serum was collected and stored. The animals were then allowed to rest for 3 weeks. At this time monocytes were collected and tested for their support of intracellular

multiplication of brucellae in the presence of the previously collected autologous sera. When the pretreatment serum was used, no inhibition of multiplication occurred. However, when monocytes from the same harvest were cultivated in the serum that had been collected immediately after meprobamate treatment, intracellular multiplication was inhibited. Thus it would appear that exposure to meprobamate so alters the serum of treated animals that monocytes cultivated in the presence of this serum no longer allow unrestricted intracellular multiplication of *B. abortus*.

Certain effects of meprobamate on specific enzyme systems are known (*8*). One may therefore hope that the ability of this drug to cause changes in monocytes that lead to properties resembling those of cells from immune animals will permit a better analysis of biochemical changes responsible for so-called cellular immunity (*9*).

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Abscission and Abscisin

In a recent report in *Science* (*1*), the isolation of an abscission-accelerating compound, which the authors called abscisin, was described by Liu and Carns. We feel that, while the report holds some promise for interesting progress, it could be misinterpreted.

First, since the test that is used to assay for the abscission activity is a cotton seedling test which had not been previously reported in the literature, it would have been helpful had Liu and Carns presented more data to illustrate the results. The four values which are given show differences which would be considered very small in the conventional bean explant test, but of course the different plant material may account for the proportionally small differences.

In studying the developmental physiology of plants, when we find a substance with the ability to accentuate a given developmental or metabolic response, we cannot then assume that it serves to accentuate this response *in situ*. Before tentatively concluding that a promotive substance in a plant extract may be involved in a developmental process, we must do more than simply show that it is present. Some correlation of its occurrence with the developmental event is rudimentary to such an implication.

Liu and Carns have extracted something from the brown shells of cotton fruits after maturation and the completion of commercial harvesting. Does the presence of an abscission-promoting substance in this material implicate it in the development of the abscission processes, which would have occurred weeks or even months earlier?

A rather complicated purification procedure is described for the cotton extract. It would have been helpful if, along with this, data had been presented to show that the fractions which were discarded during the purification were without appreciable activity in the abscission test. It is possible that the unused fractions as well as the burs themselves after extraction did in fact include compounds which may be correlated with the abscission process.

A great variety of naturally occurring substances can directly promote abscission, including such classes of compounds as sugars, auxins, amino acids, and unsaturated hydrocarbons. Extraction and purification of any of these substances would surely not warrant the coinage of a new hormonal term and its addition to the literature of plant physiology. To illustrate the great variety of types of compounds which can stimulate abscission, we have assembled the data shown in Table 1. The assay used is the bean petiole explant test, and in each case untreated controls reached 50-percent abscission in approximately 100 hours. These data point up the fact that the abscission process is a complicated product of metabolism, and that under some circumstances it can be promoted by many different types of substances. For comparison, data for some extracts from abscissing and nonabscissing bean leaves are included, in which a tentative correlation with the abscission process can be seen.

Table 1. Promotion of abscission by some widely differing types of substances. The data show the hastening of 50-percent abscission in the bean petiole explant test. The experiments were carried on in light, except for the sucrose experiments, which were in darkness.

Substance	Promotion of abscission (hr)	Reference
Sucrose ($3\times10^{-2}M$)	50	(*2*)
Alanine ($5\times10^{-3}M$)	70	(*3*)
Formaldehyde ($5\times10^{-4}M$)	69	(*3*)
Ethylene (0.01%)	65	(*4*)
Napthaleneacetic acid ($10^{-5}M$)	69	(*5*)
Extract from		
Green leaves*	0	(*4*)
Senescent leaves*	76	(*4*)

* Acetone extracts of bean leaves consisted of dilutions, with water, to ten times the original fresh weight of the tissue extracted.

The concept of control of abscission by hormonal systems other than the auxins is certainly an interesting one, but as yet evidence has not been provided for the existence of other hormones in the sense of chemical messengers controlling the development of abscission.

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We find it necessary to take issue with Leopold and Rubinstein on a number of points, and further, we wish to present what we believe to be justification for submitting the information on the isolation of abscisin in the form in which it was published.

In such a report there is not space to discuss in detail the many techniques employed. For instance, it seems to us implicit in purification work that discarded fractions are carefully screened for activity before being so-considered. Further, it should not be necessary to state that the accelerated abscission reported was highly reliable and repro-

ducible, or that large absolute differences are not required or necessarily desirable in the explant test. The cotton explant test we selected has been in use for several years (*1*), and the details were published in the proceedings of the 4th International Conference on Plant Growth Regulation (*2*).

A cursory survey of the literature clearly indicates that the specificity of explant tests for abscission activity varies greatly. It is correlated with size of explant, method and site of application of test substances, and other factors often peculiar to individual laboratories. With the techniques we used, in either beans or cotton, only a very few substances were found capable of accelerating abscission when applied to the petiole segment of the explant. Other compounds, including carbohydrates, various types of organic acids, a great many inorganic and organic substances, and toxic materials in general, delay abscission or are without effect. These results, collected over a period of 12 years, led to the conclusion that evidence for the acceleration of abscission in many instances is the result of secondary interactions rather than of a direct promotion. The cotton explant test was selected as the bioassay in part because of its specificity with respect to abscission-accelerating substances.

Evidence for the presence of an abscission accelerator in cotton fruit and for its probable role in abscission was presented at the 9th International Botanical Congress (*3*) and at various cotton defoliation and physiology conferences, with key references given in the bibliography of the report in question. To summarize these findings, the accelerator can be obtained by diffusion or extraction and can be identified either by its abscission-accelerating activity or by its inhibition of an indoleacetic acid–induced growth response. Peak production is correlated with the onset of fruit drop in cotton. Varieties with a higher percentage of fruit drop have been found to contain greater quantities of the accelerator than those with characteristically lower fruit drop. The presence of the accelerator in diffusates is indicative of its ability to move from the fruit (site of origin) to the abscission zone (site of action). Finally, the active factor is found to be concentrated in the fruit walls (the tissue which later makes up the bulk of the dried burs). Burs were selected as the material for extraction because of the need for a ready source of plant material and because preliminary tests demonstrated a similarity in the abscission and growth-inhibition responses in burs.

Thus, we agree with Addicott that ample correlative evidence exists to warrant the suggestion that this or similar substances play an active part in the abscission process. That abscisin is identical with the substance active in young fruit has not, of course, been established.

In the final analysis, the important fact is that abscisin is the first highly active compound isolated from a natural source which accelerates abscission.

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13 October 1961

Responses of Retinal Ganglion Cells to Exponentially Increasing Light Stimuli

Abstract. Action potentials of ganglion cells were recorded extracellularly from opened cat eyes. It was found that inhibition, as judged by discharge frequency, may depend upon rate of change of light intensity. Apparently the balance between excitatory and inhibitory inputs at the ganglion cell level depends upon rate of change of illumination. Visual purple bleaching or sensory adaptation taking place during the stimulation does not explain the results.

A wealth of data concerning the discharge pattern of the vertebrate retinal ganglion cells has been obtained by use of square-wave stimuli of different intensities, durations, colors, and retinal distributions. In the present work stimuli of exponentially increasing intensity were used. We felt that a study of the discharge pattern in response to stimuli of known intensity variation with time might add to our knowledge about the transmission properties of the retinal network. One well-known characteristic of ganglion cell responses to a square wave of light is the decrease in rate of discharge that sometimes occurs during the stimulation. This inhibition by light may be noted as a complete cessation of firing as long as the stimulus lasts, or it may be observed as a temporary decrease in discharge frequency below the rate that prevailed before the stimulus was applied. The experiments reported here show that in some instances the degree of inhibition, as judged by discharge frequency of the ganglion cell, is determined not only by the level of intensity as such, but is also strongly dependent upon rate of change from one level of illumination to another.

Cats decerebrated under ether narcosis were used. Action potentials were recorded extracellularly from the opened eye with glass-insulated platinum electrodes (*1*). A lamp with a tungsten ribbon filament provided diffuse, even illumination of the eye. The light intensities were measured at the surface of the eye and, therefore, serve only as a rough estimate of the retinal illumination. In each experiment the eye was first adapted to a certain steady illumination (adapting light). The light intensity was then increased exponentially to a new steady level by rotating a neutral density filter in the beam ("ramp" stimuli). Square waves were also employed. They started from the same adapting level and reached the same maximum intensity as the ramp stimuli. The total rise time of the square waves varied from 50 to 75 msec.

Figure 1 (top) shows the response to an exponential "ramp" where the total rise time is slightly more than 2 seconds. The discharge frequency of the cell decreases well below the prestimulus level during the fastest portion of the ramp, only to increase again shortly after the maximum intensity has been reached. The inhibition that occurs when a step function is applied is much less pronounced (Fig. 1, bottom).

Figure 2 illustrates the same experiment in a more quantitative manner. On three records (the two shown in Fig. 1 and a third similar one) the number of spikes within each successive 200- or 100-msec period were counted, starting 5 seconds before onset of stimulus. Then the cumulative sum of impulses was plotted against time; the continuous lines at the bottom indicate

the three stimuli. In this type of plot the slope over any chosen time interval indicates the average impulse frequency for that interval. Hence, if there is some portion of the curve with less slope during the stimulation than before, inhibition occurs. Although the precise shape of the curves in Fig. 2 depends somewhat upon the time interval over which the spikes are counted, it is obvious that the degree of inhibition in this experiment depends not only on intensity level but also on the variation of the stimulus intensity with time.

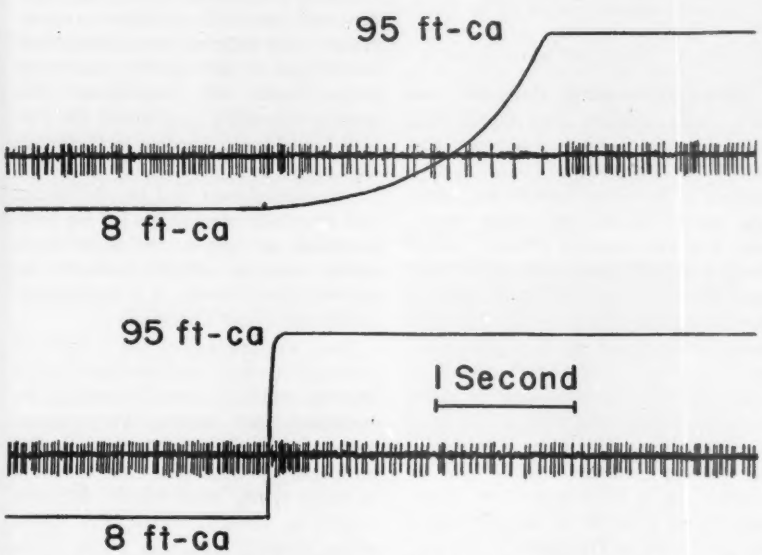

Fig. 1. Tracing of an experimental record showing action potentials from a single retinal ganglion cell in response to exponential (top) and square-wave (bottom) light stimuli.

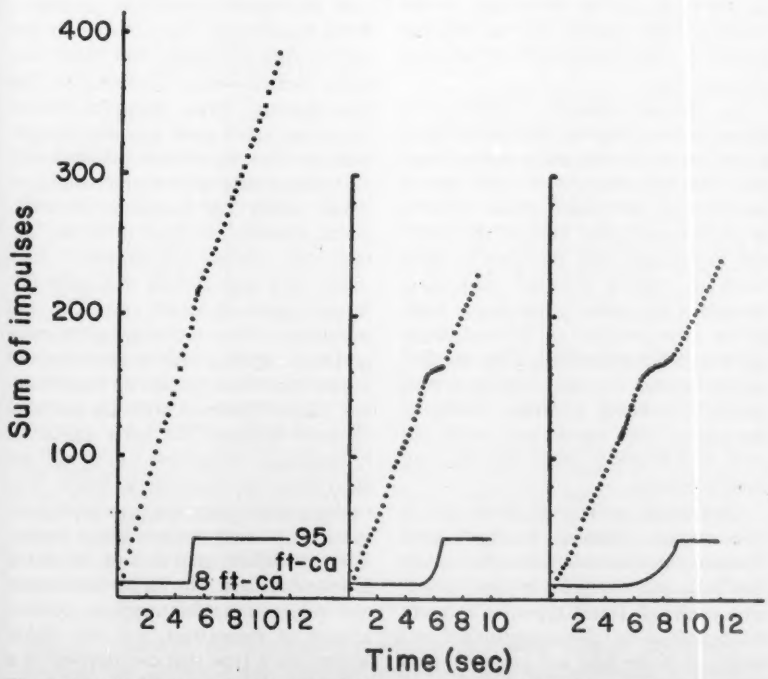

Fig. 2. Cumulative sum of action potentials versus time (dots) for three different stimuli as indicated by solid lines at the bottom. The data are from the same cell as in Fig. 1.

There is every reason to believe that the discharge frequency of a retinal ganglion cell is determined by the interplay between excitatory and inhibitory inputs which reach the ganglion cell from the receptors via inter-neurons (*2*). Our results indicate that for stimuli covering the entire receptive field of a ganglion cell, a change in the rate of increase of stimulus intensity can alter the balance between excitatory and inhibitory influences upon that cell. If the decrease in impulse frequency seen during the ramp stimulation were due to a visual purple bleaching effect or to sensory adaptation of the visual receptors, it would be difficult to explain why the spike frequency returns to the prestimulus level shortly after the stimulus has reached its maximum intensity (Fig. 1, upper tracing; Fig. 2, center and righthand plots). If the spike-frequency decrease were due to visual purple bleaching or sensory adaptation, one would also expect a decrease comparable to that observed during the fast part of the ramp stimulation during some period of the square-wave stimulation. But in several experiments a pronounced inhibition during a ramp could not be mimicked by exposing the eye to the same amount of radiant energy in the shape of a step function.

It is well known from work with square-wave stimuli that factors such as background illumination and state of adaptation, intensity and duration of stimulus, and extent and location of area stimulated within the receptive field modify the discharge pattern of vertebrate retinal ganglion cells (*2*, *3*). Our findings suggest that rate of change of stimulus intensity should be added to these parameters (*4*).

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4. This investigation was supported by research grants B-2208 and B-2165 from the National Institute of Neurological Diseases and Blindness.

7 August 1961

Meetings

Plant Geographers

The 13th International Phytogeographic Excursion (IPE) was held in Finland and Norway from 13 July to 5 August 1961. These excursions have been held periodically since 1911, each time in a different country. They were originated by British and Swiss botanists interested especially in plant geography and phytosociology and have been operated by a permanent Swiss committee. Werner Lüdi, Geobotanisches Institut Rübel, Zürich, has been president since the death of E. Rübel, one of the founders.

The purpose of the IPE is to bring together, on an extended field trip, some of the leading field botanists of several countries for common study of local vegetation and for the close and continued contact that permits and encourages an exchange of information. The interest in floristic and in vegetational geography has always been mixed. In recent years there has been increasing attention to the interrelation of vegetation and land use, and more of the participants than formerly have been associated with their national nature conservancies.

The group forming an IPE party consists of about 25 foreign participants and the members of the local committee of the host country. In the case of the 13th Excursion, there were 25 foreign participants, and 14 countries were represented. In addition, there were 12 members of the Finnish committee and three members of the Norwegian committee. Aarno Kalela was chairman and Rauno Ruuhijarvi was secretary of the Finnish committee, and Rolf Nordhagen and Olav Gjaerevoll were chairman and secretary, respectively, of the Norwegian committee. Switzerland and Sweden had four participants each, the United States had three, Denmark, Great Britain, and West Germany had two each, and there was one each from Australia, Austria, Yugoslavia, Italy, Poland, Romania, East Germany, and the Netherlands.

All regular travel of the group was in a single modern bus; special side trips were made by air, steamer, and river boat. There was, of course, a good amount of tramping about to see forest, bog, swamp, beach, and alpine vegetation. The bus travel in Finland totaled about 3000 kilometers, and that in Norway, about 2000. The Finnish part of the excursion started at Helsinki and ended at Karajoki; the Norwegian part started at Karasjok and ended at Tromsø. The first part lasted 14 days; the second, 10 days. Most of the time was spent above the Polar Circle, and the highest latitude reached was at North Cape, at more than 71°N. Many participants returned by steamer along the fjord coast to Trondheim or Bergen.

One advantage, or perhaps difficulty, of visiting these lands in the summer is the possibility of putting in about 18 hours a day. The party was often still in the field at 8 or 9 o'clock in the evening, with dinner over as late as midnight, and an early start to be made the next day.

In Finland special attention was given to two features: the forest types, according to the Cajander system, and the moor or peatland types. Tree species are very few in Finland. *Pinus silvestris* is predominant over most of the country. Associated with the pine is white birch in varying amounts and some mountain ash, willow, and so on. Only in the extreme south of Finland, especially in Schärenfinnland, does one find forests richer in tree species, with spruce, basswood, and oak. North of the central pine forests only birch occurs, and finally it drops out and only tundra remains.

Despite the poverty of the forests in tree species, Finnish botanists (and Finnish foresters are all highly qualified botanists) recognize a rather extensive array of forest types, which are distinguished by the composition and structure of the field and ground layers. These forest types, insofar as the tree layer is concerned, are essentially forest *site* types. The botanists recognize in the shrubby and herbaceous layers of the forest the shifting composition and structure that are associated with ecological conditions and that consequently determine tree spacing, quality, rate of growth, and so on. In a country where all sites are marginal-to-submarginal, in comparison with more favorable conditions at lower latitudes, comparatively slight changes in microclimate and edaphic conditions result in changes in site quality and in the characteristics of vegetation. The ground vegetation, and hence the Finnish forest types, become indicators of site quality and consequently a guide to forest management and to agricultural and other land uses. Kalela led the party to stands of each of the forest types which occur in parallel series in the conifer forest zones of Pohjanmaa, Peräpohjola, and Lappland.

Since the climate of the country is cool-to-cold-moist and evergreen plants abound, much of Finland's surface accumulates raw humus. As a consequence, Finnish botanists and geomorphologists have paid close attention to moor types. Most moors, although related to general climate, are under strong edaphic influences which determine whether ground water or atmospheric water leads in controlling moor development.

In the United States we are familiar with the type of moor that develops a flat surface along sluggish streams and quiet edges of ponds and lakes, the moor surface being controlled by the ground-water level. However, under conditions of a cool oceanic climate, when shallow depressions get filled with peat, the development of the moor continues, under the influence of atmospheric moisture, to form a convex surface—the typical *Hochmoor*. Such moors vary with climate and reach different degrees of height, convexity, and complexity. Moor surfaces may be more or less irregular, with hummocks and linear, sometimes parallel or anastomosing, ridges (*Stränge*) with flat surfaces (*Rimpis*) between. The latter are usually controlled by ground water, and the elevations, by atmospheric water. The ombrogenous ridges are poor in mineral nutrients and are occupied by a vegetation that differs from that of the richer intervening flats. The larger hummocks and ridges in northern regions contain a core of permafrost, and the *Palsamoors* are a type that can develop to a height of as much as 4.5 meters above the general surface. They are an exaggeration of the more widespread

Kodak reports on:

new personal monitoring film, very sensitive . . . hopes stirred by an artificial duck . . . how to try selling interference filters to chemists

Down with the administrative dose

Two little packets of film are extracted from a factory-fresh carton. One is locked away in a clean safe. The other is worn by a worker in the vicinity of ionizing radiation. After a month the two are processed together. Both turn out equally blank. A good densitometer discloses no difference in their optical densities. What can be inferred about the quantity of ionizing radiation the worker has absorbed?

Anybody who draws the obvious conclusion has failed fully to engage his brain cells in thought. The answer to the question depends on the sensitivity of the film. Once that is known, one can say how much of a dose the worker has probably had less than.

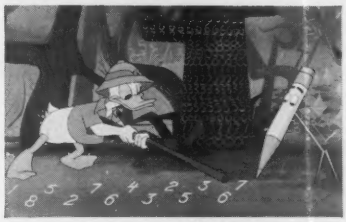
Social ethics in advanced countries require the assumption that the worker has actually *had* that much radiation. This is known as the "administrative" dose. Records are kept as in a bank. When administrative and physical doses add up to a critical figure, the worker is shifted to a different job. He may habitually spend every Saturday night cruising the center line of a busy highway at 80 m.p.h. Nevertheless, the critical figure assumes that he wants to live forever and become the progenitor of an infinite line of biologically perfect descendants. Pressure to squeeze it down will never let up, we hope.

Without relaxation of solicitude, we have taken steps to cut down the waste of his job experience. By reducing the administrative dose (which is the only kind of radiation dose he really ought ever to get on the job), we can keep him in his slot longer. It is within our power. All we have to do is make more sensitive film. This we have now done. It is called *Kodak Personal Monitoring Film, Type 3.*

The packet it comes in also includes a piece of low-sensitivity film. Its sensitivity is so low that it can measure 1800 roentgens, a horrible thought. The lower limit of dose measurement for the high-sensitivity film in the packet runs somewhere below 10 milliroentgens. The vague phrasing of that statement doesn't mean that the exact value is unimportant. The main point of this discussion is the importance of the figure. It's just that its precise determination depends on such a complexity of factors that we won't try to explain it here.

If interested, prepare yourself by studying pp. 10-53 to 10-75 of Radiation Hygiene Handbook (*McGraw-Hill Book Company, Inc., 1959*). *Then bring your knowledge up to date by requesting a data sheet on* Kodak Personal Monitoring Film, Type 3 *from Eastman Kodak Company, Special Sensitized Products Division, Rochester 4, N. Y.*

8mm audio-visuals



© Walt Disney Productions

On Sunday evening, September 24th, a new associate of ours named Walt Disney broadcasted from 168 television stations a film called "Mathmagicland." It featured an artificial duck he owns named Donald. The film illustrated the mathematical unity of nature and man, while the duck quacked in order to reassure 20,000,000 viewers that there is no harm in such a discussion.

Lots of kids who were too young for it will be ready next fall. Movies can teach conic sections as easily as pie-throwing. Moviemakers with lesser resources than Disney can also teach laudably. What bothers the classroom teacher about 16mm movies is how to get the one she wants when she wants it instead of seven weeks later. Nobody is to blame. The can of film has too many classes to visit, but relief is on the way.

Enter the *Kodak Sound 8 Projector.* It projects 8mm movies with commentary from a magnetic sound stripe on the film.

The greatly reduced cost and bulk of 8mm film and equipment are what got home movies off the ground. The improvement of sharpness and color in the 8mm Kodachrome II Film introduced this year is making movies really soar as entertainment in the home. In the schoolroom 8mm sound movies can be expected to simulate the effect of the paperback on the book business. The teacher will be able to handle a teaching film more like a weekly magazine and less like a shipment of gold bullion.

Keep your eye and ear on 8mm audio-visuals. If thinking of producing some yourself, you are welcome to talk it over with Advisor on Non-Theatrical Films, Eastman Kodak Company, Rochester 4, N. Y.

Chemical tuning

Labs without IR spectrophotometers properly consider themselves underprivileged.

This cute remark could well launch a commercial for spectrophotometers, except that we sell none. We sell what physicists know as optical interference filters, and we are trying here to bridge the conceptual gap from spectrophotometers to these filters.

The filters offer means to exploit in a chemical plant the physical phenomena that spectrophotometers exploit in the laboratory. Suppose, for fantasy's sake, that you wanted to flood a reaction *preferentially* with energy of exactly that frequency to which a certain carbon-nitrogen bond responds. An interference filter system could probably be made for the job.

An interference filter is tunable in manufacture for wavelengths from 0.4μ to 12μ. Unlike gelatin or glass filters, its curve doesn't depend on what colorants happen to be available. It can provide a single spectral spike of transmittance but is not limited to that. It can also be designed to cut out energy below a stated frequency or above a stated frequency. It can cut very sharp. It is thermally, chemically, and mechanically rugged. It costs a great deal less than a laser (which, while it can emit Niagaras of monochromatic energy, must work with the quantum states that nature has in stock). It can be large. It can be designed to monitor a process stream continuously for the presence or absence of any substance possessing a suitable energy-absorbance curve.

It can be the subject of an inspirational talk with Eastman Kodak Company, Special Products Division, Rochester 4, N. Y. You bring the curves.

This is another advertisement where Eastman Kodak Company probes at random for mutual interests and occasionally a little revenue from those whose work has something to do with science

Kodak
TRADE MARK

Strängе. The permafrost at midsummer may be as little as 0.5 meter below the surface of the peat.

Two other types of peatland are the peatland which develops on wooded slopes, usually in moist birch types at various altitudes, and the *Hangmoor*, which occurs on slopes of various gradient and is dependent on a continuous supply of up-slope ground water.

Except for some high, rough plateaus, Norway is a country of rugged relief, of fjords where the mountains and valleys reach the sea, of alpine tundra, snow fields, and glaciers—all in strong contrast to the prevailing low relief of Finland.

Although vegetation was dealt with to some extent by the IPE group, especially that of salt marshes and alpine tundra, in Norway particular attention was paid to the occurrence of rare species representing various floristic elements: the Circumboreal, the Siberian, the American, the Arctic, and the South and Central European. The interest was more in flora than in the structure of vegetation. Exceptions were the snow-bed communities in the alpine zone, which had been studied by Gjaerevoll, and the salt marshes and alpine fields, which Nordhagen had studied.

Considerable interest was aroused by the differences between the *Carex nardina-Kobresia myosurioides-sociation* in these regions and that familiar to phytosociologists who had worked in the European Alps. Interest centered also in the flora of dolomitic mountains such as Jøvaren, Børselv, and Duken, the latter at North Cape.

Both of the local committees had prepared printed guides, background papers, and reprints pertinent to the excursion, and all aspects of the travel, meals, and accommodations had been carefully worked out. The Finnish committee supplemented their guidebook with daily handouts of mimeographed plant lists and analyses of vegetation for each of the many botanizing stops. These excursions are occasions for research as well as botanical sight-seeing, and the Swiss Committee in recent years has published a series of contributions from the participants, sometimes running to several hundred pages. In addition, many of the participants publish general or scientific accounts of their experiences in their national periodicals.

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Topology

Before an ominous background of ever-increasing international tensions, mathematicians have recently completed a highly successful international symposium on topology and its relation to modern analysis and algebra. The symposium, which was held from 1 to 8 September in Prague, was sponsored jointly by the International Mathematical Union and the Czechoslovak Academy of Sciences.

It was interesting, and of course no surprise, to find that a large proportion of the slightly more than 100 participants came from Communist bloc countries. Only two or three of the persons in attendance had also been at the International Colloquium on Differential Geometry and Topology, held in connection with the celebration of the 50th anniversary of the Swiss Mathematical Society in Zurich last year (*1*). Specifically, there were 12 symposium participants from the U.S.S.R.; 25 from Poland; 24 from the United States; one each from Great Britain, Cuba, Mexico, Bolivia, West Germany, and Italy; two each from Japan, India, Holland, and Austria; three each from East Germany, Yugoslavia, and Hungary; six from France; and eight from Romania. The six French delegates were all young mathematicians affiliated with the National Center of Scientific Research. It is impossible in this brief account to give the names of all the American participants. Among them were M. H. Stone, who spoke on "Some topological aspects of conformal mapping"; Einar Hille, whose paper was entitled "Remarks on transfinite diameters"; and Angus E. Taylor, who reported on "The boundary of the spectrum of a linear operator."

A large group of Czechoslovak mathematicians were both generous and tireless in their efforts to have all things go smoothly, and one could not fail to be impressed by the obvious and earnest desire of the local symposium participants to be friendly, cooperative, and helpful.

The International Hotel was headquarters for the symposium; it was there that most of the scientific sessions were held, and that most of the foreign participants were housed. Some of the rooms were equipped with radios, and participants obtained news broadcasts from Munich on the Voice of America, and also from Moscow. At the hotel, prepaid Cedok (official Czechoslovak

Tourist Agency) vouchers were redeemed in Czechoslovak currency. If additional funds were desired, travelers checks were cashed and foreign currency was exchanged.

The symposium was opened on 1 September with words of welcome from professors Novák (chairman of the organizing committee), Kosesnik (vice president of the Czechoslovak Academy of Sciences), and Katetov (vice chairman of the organizing committee). After these greetings, a memorial assembly was held in tribute to E. Cech, an outstanding Czechoslovak mathematician who had had an active part in making plans and arrangements for the symposium prior to his death on 15 March 1960. Memorial addresses were presented by Katetov, Stone, Alexandrov, and Kuratowski.

At the first scientific session a keynote speech was presented by P. S. Alexandrov (U.S.S.R.). This was followed by addresses on "Relations of topological spaces" (A. D. Wallace, U.S.) and "Applications of topology to foundations of mathematics" (R. Sikorski, Poland). Additional scientific sessions were held on 2 September and on each day but one of the following week.

The topic of the symposium was the present status of the theory of topological spaces. The discussion of applications to functional analysis and modern algebra, which came up in a number of the papers, made the work seem somewhat less abstract than the developments discussed at the Colloquium on Differential Geometry and Topology in the summer of 1960. The symposium participants were supplied with abstracts which had been prepared in advance, and with periodic reviews of the program of the day. The *Proceedings* of the symposium will be published by the organizing committee.

Communications were printed in both Russian and English, but there was no restriction on the language used by individual speakers in the presentation of papers. However, an outstanding feature of the symposium was the extensive use of English. Similarly, a review of the references cited in the portfolio of abstracts shows that a large majority of the references were to papers printed in English, even though published, in many cases, in journals of non-English-speaking countries. Publications of the American Mathematical Society were cited frequently. The references covered a wide range—from Hausdorff's *Mengenlehre*, published in Leipzig in 1914, through Kuratowski's *Topologie I* (Warsaw, 1948) and *Topologie II* (Wroclaw, 1950) and the results of last year's colloquium in Zurich, to the research papers of Frolík, which are due to appear in the *Czech Mathematical Journal* at some future date. A number of speakers discussed problems which are still open.

Among the activities planned for hours when scientific sessions were not in progress were all-day tours to Karlsbad and Marienbad, world-famous spas in Western Bohemia. Although one caught occasional glimpses of large industrial developments, these tours were mainly through agricultural and vacation areas in the western part of the country.

At the final session on 8 September, Alexandrov, Stone, and Kuratowski spoke briefly on the accomplishments and the importance of this international symposium. Katetov, speaking in the name of the Czechoslovak mathematicians, then brought the scientific sessions to a close.

The members of the organizing committee for this highly significant and cooperative endeavor were as follows: J. Novák, chairman; M. Katetov and K. Kuratowski, vice chairmen; Z. Frolík, secretary; S. Schwarz and K. Koutsky. The administrative secretary was Mrs. K. Trojanová.

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Reference

1. L. Guggenbuhl, *Math. Teacher* **54**, No. 5 (1961).

Poultry Science

In 1940, 4½ pounds of feed was required to add 1 pound of live weight to a broiler; in 1961, slightly more than 2 pounds of feed was sufficient. This is a remarkable achievement, and it may have more real significance in the cold war than a space spectacular. But this is not an easy point to make—least of all with the 700 members of the Poultry Science Association who assembled at the Pennsylvania State University from 8 to 11 August in their 50th annual meeting.

In point of fact, T. C. Byerly, deputy administrator of the Agricultural Research Service, told the poultry scientists in the annual presidential address, 2 pounds of feed for a pound of broiler isn't really anything to boast about in terms of real energy conversion rates. Nor was this only the view of the presiding officer; among the 340 papers presented were many indicating that the 2-pounds-of-feed barrier was destined to go the way of the 4-minute mile.

Byerly outlined a long series of besetting problems for the researcher. These included the growing incidence of avian leukosis, a virus-transmitted disease that is now the major killer of laying flocks; lack of understanding of the genetics of disease resistance and of the effect of photo-periodism in poultry; incomplete understanding of ovulation and egg production; and lack of any significant advances, to date, in the processing of poultry.

The meetings were grouped in eight divisions—pathology, nutrition, physiology, genetics, environment, marketing, instruction, and extension. At a general session on the opening day, Eric A. Walker, president of the Pennsylvania State University, commented on the fate of the education bill in Congress.

He strongly challenged the cliché that federal aid to education is a new and radical departure (George Washington strongly supported a national university!) and cited the agricultural research program, which dates back to 1887, as the classic example of effective federal aid to education. Local initiative and direction and wide latitude in the use of funds were hallmarks of this program, and the results have been outstanding.

The Poultry Science Association provides an excellent example of cooperation between universities and affiliated industries, and the annual awards dinner becomes an occasion of considerable interest, inasmuch as the winning plaques are accompanied by substantial amounts of cash. The Borden award, consisting of a plaque and $1000 for "original distinctive work demonstrating sound research in poultry nutrition," went to F. W. Hill (University of California). The Pfizer extension teaching award of $1000 for "an outstanding program of work . . . in poultry extension" was presented to Harry C. Whelden, Jr. (University of Maine). M. L. Sunde (University of Wisconsin) received the $1000 American Feed Manufacturers Association award for research in poultry nutrition. The Ralston Purina teaching award, also of $1000, for excellence in teaching, went to Jack Long (Purdue University).

The biennial award of $1000, given by the Institute of American Poultry Industries for outstanding work in poultry- and egg-products technology over a 3-year period, was presented to Daniel Fromm (North Carolina State College). The Poultry Science Research award of $200 for outstanding research during the past year was awarded to James V. Craig (Kansas State University).

F. H. Wilcox (University of Maryland), was selected as the winner of the $1000 August Hande award for the outstanding U.S. paper submitted in the World's Poultry Congress Paper Prize. The travel grant of $1000 from the Poultry Science Association was awarded to Donald de Fremery (Western Regional Research Laboratory, Department of Agriculture).

New officers elected by the association were as follows: C. S. Shaffner (University of Maryland), president; R. G. Jaap (Ohio State University), first vice president; J. C. Driggers (University of Georgia), second vice president; and C. B. Ryan (Texas Agricultural and Mechanical College), secretary-treasurer. T. C. Byerly, L. Z. Eggleton, and M. L. Sunde were elected

directors. The association will meet at the University of Illinois in 1962, at Oklahoma State University in 1963, and at the University of Minnesota in 1964.

Elected as fellows of the association were B. B. Bohren (Purdue University), E. W. Callenbach (Lebanon, Va.), J. R. Cavers (Ontario Agricultural College), I. Michael Lerner (University of California), and A. E. Tomhave (University of Delaware).

A. J. G. MAW
Pennsylvania State University, University Park

Forthcoming Events

December

17–18. International Congr. of Comparative Pathology, 9th, Paris, France. (L. Grollet, Comité International Permanent des Congrès de Pathologie Comparée, 63 Avenue de Villiers, Paris 17°)

19–23. Inter-American Congr. of Psychology, 7th, Monterrey, Mexico. (G. M. Gilbert, Psychology Dept., Long Island Univ., Brooklyn 1, N.Y.)

22–29. Plant Tissue and Organ Culture, intern. symp., New Delhi, India. (P. Maheshwari, Univ. of Delhi, Delhi)

26–28. History of Science Soc., annual, Washington, D.C. (J. C. Greene, 1121 Iowa Ave., Ames, Iowa)

26–31. American Assoc. for the Advancement of Science, annual, Denver, Colo. (R. L. Taylor, AAAS, 1515 Massachusetts Ave., NW, Washington 5)

The following 45 meetings are being held in conjunction with the AAAS annual meeting.

AAAS Cooperative Committee on the Teaching of Science and Mathematics (J. R. Mayor, AAAS, 1515 Massachusetts Ave., NW, Washington, D.C.). 27 Dec.

AAAS Southwestern and Rocky Mountain Division (M. G. Anderson, New Mexico State Univ., University Park). 26–30 Dec.

Academy Conf. (J. G. Arnold, Jr., Loyola Univ., New Orleans, La.). 27–28 Dec.

Alpha Epsilon Delta (N. F. Witt, Univ. of Colorado, Boulder). 28–29 Dec.

American Astronautical Soc. (M. Pitkin, Martin-Denver Co., Denver, Colo.). 28–29 Dec.

American Astronomical Soc. (H. J. Smith, Yale Observatory, 135 Prospect St., New Haven, Conn.). 26–30 Dec.

American Economic Assoc. (K. E. Boulding, Univ. of Michigan, Ann Arbor). 26 Dec.

American Educational Research Assoc. (D. D. Feder, San Francisco State College, San Francisco, Calif.). 30 Dec.

American Nature Study Soc. (S. G. Baldwin, Danville, Ill.). 27–30 Dec.

American Physiological Soc. (R. E. Smith, Univ. of California, Los Angeles). 29 Dec.

American Political Science Assoc. (J. Korbel, Social Science Foundation, Univ. of Denver, Denver, Colo.). 27 Dec.

American Psychiatric Assoc. (D. A. Hamburg, Stanford Medical Center, Palo Alto, Calif.). 27 Dec.

American Soc. of Criminology (G. H. Barker, Dept. of Sociology, Univ. of Colorado, Boulder). 29–30 Dec.

American Soc. of Naturalists (E. W. Caspari, Univ. of Rochester, Rochester, N.Y.). 27 Dec.

American Soc. of Zoologists (R. L. Watterson, Univ. of Illinois, Urbana). 27–30 Dec.

American Sociological Assoc. (C. Taeuber, Bureau of the Census, Washington, D.C.). 29 Dec.

American Statistical Assoc. (J. A. Niederjohn, Ideal Cement Co., Denver, Colo.). 29–30 Dec.

Association of American Geographers (M. J. Loeffler, Univ. of Colorado, Denver). 26–28 Dec.

Association for Computing Machinery (W. F. Cahill, Goddard Space Flight Center, Greenbelt, Md.). 28 Dec.

Beta Beta Beta Biological Soc. (Mrs. F. G. Brooks, Box 515 Ansonia Station, New York 23). 26–27 Dec.

BIO (Biomedical Information-Processing Organization) (R. S. Ledley, Natl. Biomedical Research Foundation, Silver Spring, Md.). 27 Dec.

Biometric Society, WNAR (F. Graybill, Statistical Laboratory, Colorado State Univ., Fort Collins). 28 Dec.

Committee on Desert and Arid Zones Research, Southwestern and Rocky Moun-

tain Div. of AAAS (T. L. Smiley, Univ. of Arizona, Tucson). 30 Dec.

Conference on Scientific Communication (C. D. Leake, Ohio State Univ., Columbus). 30 Dec.

Conference on Scientific Manpower (T. J. Mills, Natl. Science Foundation, Washington, D.C.). 27 Dec.

Ecological Soc. of America (R. S. Miller, Univ. of Saskatchewan, Saskatoon, Canada). 27–29 Dec.

Institute of Management Sciences (M. M. Flood, Mental Health Research Inst., Univ. of Michigan, Ann Arbor). 29 Dec.

Mathematical Assoc. of America, Committee on Undergraduate Program in Mathematics (R. J. Wisner, Michigan State Univ., Oakland, Rochester). 30 Dec.

Metric Assoc. (R. P. Fischelis, 502 Albee Bldg., NW, Washington, D.C.). 27–30 Dec.

National Assoc. of Biology Teachers (Miss M. Beuschlein, Chicago Teachers College, Chicago, Ill.). 27–30 Dec.

National Assoc. for Research in Science Teaching (Miss E. M. Selberg, Colorado State College, Greeley). 27–30 Dec.

National Assoc. of Science Writers (H. B. Nichols, U.S. Geological Survey, Washington, D.C.). 27 Dec.

National Geographic Soc. (R. Gray, National Geographic Soc., Washington, D.C.). 30 Dec.

National Science Teachers Assoc. (Miss M. Gardner, Natl. Science Teachers Assoc., Washington, D.C.). 27–30 Dec.

National Speleological Soc. (W. R. Halliday 1117 36 Ave., East, Seattle, Wash.). 29 Dec.

Philosophy of Science Assoc. (C. W. Churchman, Univ. of California, Berkeley). 29 Dec.

Scientific Research Soc. of America (D. B. Prentice, 51 Prospect St., New Haven, Conn.). 29 Dec.

Sigma Delta Epsilon (Miss E. B. Thurman, Natl. Institutes of Health, Bethesda, Md.). 28 Dec.

Society for General Systems Research (R. L. Meier, Univ. of Michigan, Ann Arbor). 29 Dec.

Society for Industrial and Applied Mathematics (D. L. Thomsen, Jr., I.B.M. Corp., White Plains, N.Y.). 29 Dec.

Society of Protozoologists (N. D. Levine, College of Veterinary Medicine, Univ. of Illinois, Urbana). 27–30 Dec.

Society of the Sigma Xi (T. T. Holme, 51 Prospect St., Yale Univ., New Haven, Conn.). 29 Dec.

Society of Systematic Zoology (C. F. Lytle, Tulane Univ, New Orleans, La.). 27–30 Dec.

Tau Beta Pi Assoc. (R. H. Nagel, Univ. of Tennessee, Knoxville). 29 Dec.

United Chapters of Phi Beta Kappa (C. Billman, 1811 Q St., NW, Washington 9). 29 Dec.

27–29. American Economic Assoc., New York, N.Y. (J. W. Bell, AEA, Northwestern Univ., Evanston, Ill.)

27–29. American Folklore Soc., Cincinnati, Ohio. (T. P. Coffin, 110 Bennett Hall, Univ. of Pennsylvania, Philadelphia 4, Pa.)

27–29. American Geophysical Union, 1st western natl., Los Angeles, Calif. (A. N. Sayre, U.S. Geological Survey, Washington 25)

27–29. American Physical Soc., Los Angeles, Calif. (K. K. Darrow, 538 W. 120 St., New York 27)

27–29. Western Soc. of Naturalists, Eugene, Ore. (I. A. Abbott, Hopkins Marine Station, Pacific Grove, Calif.)

27–30. Institute of Mathematical Statistics, annual, New York, N.Y. (D. C. Riley, American Statistical Assoc., 1757 K St., NW, Washington 6)

28–29. American Chemical Soc., Div. of Industrial and Engineering Chemistry, Newark, Del. (Scientific Liaison Office, Natl. Research Council, Sussex Dr., Ottawa, Canada)

28–29. Linguistic Soc. of America, annual, Chicago, Ill. (A. A. Hill, Box 7790 University Station, Austin 12, Texas)

28–29. Northwest Scientific Assoc., Spokane, Wash. (E. J. Larrison, Univ. of Idaho, Moscow)

28–30. Archaeological Inst. of America, Detroit, Mich. (L. A. Campbell, 5 Washington Square N., New York 3)

28–30. Phi Delta Kappa, Bloomington, Ind. (R. S. Merkel, Indiana Central College, Indianapolis 27)

January

2–3. California Assoc. of Chemistry Teachers, San Luis Obispo, Calif. (R. Major, 1736 N. Sierra Bonita Ave., Hollywood 46, Calif.)

8–12. International Heat Transfer Conf., Institution of Mechanical Engineers, London, England. (Secretary, IME, 1 Birdcage Walk, Westminster, London, S.W.1)

8–12. Society of Automotive Engineers, annual, Detroit, Mich. (R. W. Crory, SAE, 485 Lexington Ave., New York 17, N.Y.)

8–13. Central Treaty Organization, Role of Science in Natural Resources, Lahore, Pakistan. (Office of Intern. Conferences, Dept. of State, Washington 25)

9–11. Reliability and Quality Control, 8th natl. symp., Institute of Radio Engineers and American Inst. of Electrical Engineers, Washington D.C. (Scientific Liaison Office, Natl. Research Council, Sussex Dr., Ottawa, Ont., Canada)

9–12. Radioactive Isotopes in Clinical Medicine and Research, 2nd symp., Bad Gastein, Austria. (R. Höfer, Garnisongasse 13, Vienna IX, Austria)

9–19. Synoptic Meteorology Code Problems, World Meteorological Organization, Toronto, Ont., Canada. (WMO, 41 Avenue Giuseppe Motta, Geneva, Switzerland)

11. Role of Hormones in Protein Synthesis, Assoc. of Vitamin Chemists, Chicago, Ill. (H. S. Perdue, Abbott Laboratories, N. Chicago)

15–17. American Pomological Soc., Toronto, Canada. (G. M. Kessler, Dept. of Horticulture, Michigan State Univ., E. Lansing)

17–19. Instrument Soc. of America, winter conf. and exhibit, St. Louis, Mo. (W. H. Kushnick, ISA, 313 Sixth Ave., Pittsburgh 22, Pa.)

18–31. Tropical Cyclones, inter-regional seminar, World Meteorological Organization, Tokyo, Japan. (WMO, 41 Avenue Giuseppe Motta, Geneva, Switzerland)

22. American Ethnological Soc., New York, N.Y. (N. F. S. Woodbury, Arizona State Museum, Univ. of Arizona, Tucson)

(See issue of 1 December for comprehensive list)

New Products

Neutron generator produces a continuous mono-energetic 14-Mev-per-neutron flux of 10^8 neutrons per second and a pulsed 14-Mev flux of 10^9 to 10^{10} neutrons per second by the deuterium-tritium reaction. The neutron source tube includes a Penning ion source, one-stage accelerating system, and a target and replenisher system, which are enclosed in a hermetically sealed glass envelope filled with a mixture of deuterium and tritium (1:1). The tube is mounted in a cylindrical oil-filled steel housing. Deuterium and tritium ions impinge on a target of titanium deposited on silver and generate neutrons. The target is shaped and sized to provide complete coverage by the electron beam to assure maximum loading. Negative high voltage, variable from 0 to 125 kv, is supplied through a shielded flexible cable to permit remote operation. A second cable provides leads for energizing the replenisher system and for ion-source voltage. The replenisher system has a filament surrounded with a zirconium wire that can be impregnated with hydrogen isotopes. When the filament is heated the isotopes are emitted to replenish the tube atmosphere. The neutron output is pulsed by an integral universal pulse generator and amplifier. Pulse duration may be varied from 10 to 500 μsec, and repetition rate from 60 to 3000 per second. (Philips Electronics and Pharmaceutical Industries Corp., 750 South Fulton Ave., Mount Vernon, N.Y.)

Circle 1 on Readers' Service card

Vertical-sensing element is essentially a two-axis, electrical plumb bob. A wire-suspended pendulum acts as the moving member of two orthogonally mounted differential transformers to provide phase sensitive a-c output signals proportional to the tilt angle. The instrument is hermetically sealed and fluid filled for damping and resistance to shock and vibration. A bellows is provided for fluid expansion. Excitation is 10 volts, 1000 cy/sec. Sensitivity is 20 mv ± 2 mv/min, up to 10 min; 20 mv ± 3 mv/min up to 20 min. While designed to be operated in a controlled-temperature-environment, the senser is said to be usable over a wide temperature range with less accuracy. (General Precision, Inc., 1150 McBride Ave., Little Falls, N.J.)

Circle 2 on Readers' Service card

Magnetometer (Fig. 1) uses a helium lamp, a helium absorption cell, and an infrared detector to measure changes in the earth's field with sensitivity said to be approximately 0.01 gamma. Operating temperature range is −40° to +125°F. The system operates by absorption of 10,930-A energy by metastable helium atoms. A radio-frequency power supply is used to light the helium lamp and to excite helium in the absorption cell into three magnetically split sublevels. One-micron energy from the lamp optically pumps the atoms causing a greater population of the upper sublevels. A resonance oscillator is used to provide a second radio-frequency field for redistribution of the sublevel populations. The amount of energy absorbed is monitored by the infrared detector. The resonance oscillator is frequency modulated to produce an absorption line at the detector. The absorption signal is fed back to control the frequency of the oscillator. Variation of frequency with magnetic field is 2.8 Mcy/sec per gauss. The frequency can be counted or discriminated to provide a value for the change of magnetic field. (Texas Instruments, Inc., 6000 Lemmon Ave., Dallas 22, Tex.)

Circle 3 on Readers' Service card

An instrument that **measures blood volume** operates on the principle of dilution of radioactively labeled material. Operation of the instrument is begun by setting a function switch to "reset." The dose of radioactive tracer material to be administered is then placed in the instrument, and the function switch is turned to "measure dose." If the dose is stronger than necessary for an accurate determination, or too weak, a panel light indicates the fact. If the dose is correct, it is measured and the value is stored in the instrument's memory.

When the correct dose has been measured, a reference sample of blood is withdrawn and transferred to a sample tube, and the dose is injected into the same site. The empty dose syringe is returned to the instrument, and the function switch is turned to

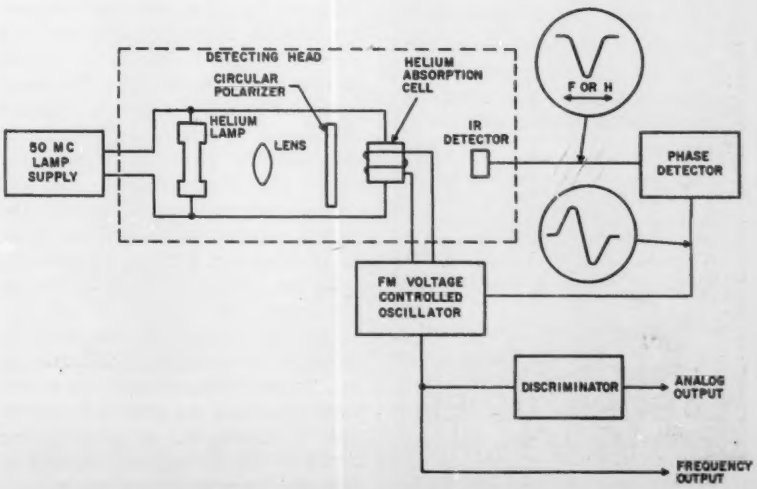


Fig. 1. Metastable helium magnetometer.

The information reported here is obtained from manufacturers and from other sources considered to be reliable. Neither *Science* nor the writer assumes responsibility for the accuracy of the information. A Readers' Service card for use in mailing inquiries concerning the items listed is included on page 1809. Circle the department number of the items in which you are interested on this card.

"subtract residue." The instrument then compensates automatically for instrument background and corrects the memory to the net injected dose by subtracting the value of the dose residue remaining in the emptied syringe. After suitable mixing time has elapsed (10 min), a postmix sample is withdrawn from a site different from that of the injection and transferred to a second sample tube.

Finally, the reference and postmix samples are placed in the instrument and the switch is set to "compute volume." The instrument automatically corrects for instrumental background again, subtracts sample activity indicated by the reference sample, and computes the blood volume making corrections for radioactive decay of the dose. Blood volume is indicated by a pointer-type meter with a 4-in. scale. Accuracy is said to be ± 5 percent. (Atomium Corp., 940 Main St., Waltham 54, Mass.)

Circle 4 on Readers' Service card

Process stream refractometer uses the critical-angle technique to measure highly viscous, extremely dark, or opaque liquids. In operation, a light beam from an incandescent source is directed through a lens and out the back of the instrument's explosion-proof housing to a prism that is in contact with the sample stream. The light beam is refracted at the interface between the prism and the process fluid and directed back through a beam deflector to two cadmium-sulfide photodetectors. One cell is located in the pure white light section while the other is mounted at the critical-angle point where the field changes from light to dark. As the refractive index of the fluid changes, the critical angle changes and the amount of light falling on the second detector varies accordingly. The signal generated by this variation is amplified and causes a servomotor to drive a glass deflector plate that compensates for the change of refractive index and restores the null-signal condition. The motion required of the deflector plate for restoration of balance is detected by a precise potentiometer geared to the servomotor. A signal from the potentiometer provides an indication or record of the variation in refractive index. Temperature compensation is provided by sensing the prism temperature with a thermistor. A compensating circuit makes corrections for normal variation in process stream temperature. To prevent coating of the prism sur-

face, a wiper mechanism can be provided which will wipe the prism surface periodically. Prism mounting heads can be provided for lines with a diameter of from 0.25 to 2 in. (Waters Associates, 45 Franklin St., Framingham, Mass.)

Circle 5 on Readers' Service card

Portable infrared spectrophotometer is designed for airborne or satellite-borne applications. The instrument, a self-calibrating, grating type, when connected to a recorder or oscilloscope, provides repeatedly scanned spectral records of radiation collected from an external source. With a grating which has 150 lines per millimeter, the spectral records cover a 2.2-μ band. This band may be adjusted to fall anywhere within the range 1.4 to 5.5 μ. Resolution is said to be better than 330 A with a 1-mm slit.

Radiation is collected by a 4-in. aperture, $f/2.7$ Dahl-Kirkam reflector and focused on the entrance slit where it is modulated by a 300-cy/sec chopper. Radiation passing through the slit falls upon the lower portion of a narrow spherical-segment mirror and is collimated and directed to the grating. The grating angle is periodically varied to provide scanning. Scan rate is continuously adjustable between 1.5 and 8 sec per scan. The dispersed radiation is returned to the upper portion of the spherical mirror and focused back upon the exit slit, and then it is condensed upon a photoconductive detector. In the standard model, the detector is a lead-selenide unit cooled to −80°C. A variety of other detectors can be used. (Perkin-Elmer Corp., Norwalk, Conn.)

Circle 6 on Readers' Service card

An **x-y plotter** (48 in. by 48 in.) is said to be accurate to ±0.001 in. over its entire working surface. The instrument uses digital techniques for locating points. The plot command is inhibited until input and carriage data are in exact agreement. Input may be by keyboard, punched paper tape, punched card, or magnetic tape; output may be by punched paper tape, punched card, or electric typewriter. Location of the carriage is also indicated visually by numeral indicator tubes. Interchangeable heads are available for printing, scribing, inking, reading, and exposing light-sensitive film. Plotting sheets are held to the table by a vacuum system. Slewing speed is 4 in./sec with greater speeds available. A combined speed-

and-direction joystick control mounted on the control panel permits the operator to position the carriage at any desired location. (Gerber Scientific Instrument Co., 89 Spruce St., Hartford, Conn.)

Circle 7 on Readers' Service card

Electron-microprobe display console is to be used with electron-beam microprobe analyzers. It will display the location and concentration of up to four separate x-ray spectra simultaneously. Alternatively, one channel may be used to display back-scattered electrons. The console provides the raster drive for both the electron microprobe beam and the cathode-ray tubes. The *x*-axis deflection is a linear sawtooth wave form with sweep time adjustable between 1 and 30 sec per line. The *y*-axis deflection is a stepped voltage signal synchronized with the retrace of the *x*-axis sweep. The raster may consist of 8, 16, or 32 lines. Stabilized d-c amplifiers are used to amplify the signals derived from scanning the sample, and a stable d-c coupling circuit is used to control the grids of the cathode-ray tube. (Elcor, Inc., 1225 W. Broad St., Falls Church, Va.)

Circle 8 on Readers' Service card

Potentiometer tester, the type 2398, supplies *x* and *y* d-c signals representing potentiometer shaft resistance and rotation, respectively, to the manufacturer's *x-y* recorder or any other recorder of similar input characteristics. Operating in two switch-selected ranges, 1 ohm to 1 megohm and 10 ohms to 10 megohm, the instrument provides 120-db resistance measurement capability. Eight precise resistors provide calibration checks at each 20-db point. Rotation range is 0 to 360 deg. Recording time is variable from 15 to 60 sec for full rotation depending on the slope of the curve. The *y*-axis of the recorder is driven by a signal representing the logarithm of test resistance. The signal is the output voltage difference from two model 60B logarithmic converters, each of which provides a d-c output proportional to the log of an a-c or d-c input. Accuracy of the log *R* portion of the system is said to be ±0.4 percent of full scale, and accuracy of angular rotation ±0.2 percent of full scale. (F. L. Moseley Co., 409 N. Fair Oaks Ave., Pasadena, Calif.)

Circle 9 on Readers' Service card

Ultrasonic generator is a hand-held device the tip of which radiates ultrasonic energy. Liquid or other material may be processed while in a small beaker or test tube by inserting the tip. The device requires no special handling and is said to provide no electrical or acoustic danger. Frequency of operation is 25 kcy/sec. Eight power levels are provided. The excitation unit is connected by cable to the hand-held probe. (Heat Systems Co., 777 Northern Blvd., Great Neck, N.Y.)

Circle 10 on Readers' Service card

Micropositioner is an optical mechanical device for measuring small angles in the laboratory or field. The device is a prism coupled for rotation to a micrometer head. Each division of the micrometer readout corresponds to 0.1 sec of angular displacement of the reflecting prism. Maximum angular displacement is 16.7 min about a vertical axis. Accuracy is said to be 0.25 sec (r.m.s.). (Optomechanisms Inc., Industrial Park No. 1, Plainfield, N.Y.)

Circle 11 on Readers' Service card

A d-c voltage reference has seven panel dials to provide seven-digit resolution in three ranges from 0 to more than 1000 volts, positive or negative. Output voltage is said to be accurate to within ± 0.01 percent of the dial setting

and stable within 50 parts per million. Output current up to ± 25 ma is provided. Noise and ripple are stated to be less than 0.0001 percent, peak-to-peak, of the dial setting. (Cohu Electronics, Inc., Box 623, San Diego 12, Calif.)

Circle 12 on Readers' Service card

Stable light source consists of a solid-state power supply that maintains a selected tungsten-filament lamp at constant intensity. The lamp assembly is nested within the power-supply case for convenient transport or storage. Candlepower ripple is said to be less than ±0.0001 percent. Warm-up time is 10 min at room temperature. The electrical requirement is 100 to 135 volts, 60 cy/sec. (Quantametric Devices, Inc., P.O. Box 1107, Binghamton, N.Y.)

Circle 13 on Readers' Service card

Multiple coincidence unit is a fully transistorized instrument that accepts up to five input signals and delivers three simultaneous output signals. The main chassis contains three independent fast-slow coincidence circuits and up to five plug-in circuit boards for processing signals from as many as five radiation detectors. Coincidence resolving time is adjustable from 0 to 180 nsec. The three coincidence circuits, each of which represents a different set of coincidence conditions, can be used to direct data to three separate sections of the analyzer memory, making it possible to study three aspects of a decay scheme at the same time. (Cosmic Radiation Labs., Inc., Bellport, N.Y.)

Circle 14 on Readers' Service card

Instrument transformer, for measurement of amplitude and wave form at voltages up to 300 kv, features rise time of 20 nsec and drop of 0.1 to 0.0005 percent per μsec. Over-all dimensions are 8 by 2¾ by 9½ in. (Pearson Electronics, Inc., 707 Urban Lane, Palo Alto, Calif.)

Circle 15 on Readers' Service card

Projection microscope provides magnification up to 1500 with optional oil-immersion objectives. The instrument may be used in horizontal or vertical position. A prefocused 100-watt lamp is the light source. Heat-absorbing filters are built into the light-condensing system. A polarizing filter provides variable illumination intensity. The instrument can also be used for direct viewing. (National Instrument Co., Baltimore 15, Md.)

Circle 16 on Readers' Service card

Amplitude distortion analyzer determines the amplitude-probability distribution of random signals. In operation, a voltage is preset by a front-panel control, and the percentage of time by which the applied signal exceeds the preset voltage level is read directly from the instrument scale. Three ranges: 100, 10, and 1 percent are provided. The voltage level may be remotely controlled by applying an external signal to a connector. In addition, a d-c analog of the meter reading is provided. This permits an automatic plot of the amplitude distribution of the signal to be obtained. Maximum switching rate is 5 Mcy/sec; amplitude accuracy is said to be ±3 percent of full scale. The instrument is fully transistorized. (Quan-Tech Laboratories, Inc., Boonton, N.J.)

Circle 17 on Readers' Service card

Linear actuator provides positioning accuracy said to be repeatable to within ±0.0025 in. without feedback. Rated thrust is 500-lb tension and compression with maximum thrust 1000 lb. Stroke is continuously adjustable from 0 to 6 in. An optional potentiometer can be provided for position indication. (Lear Incorporated, Electromechanical Division, 110 Ionia Ave., NW, Grand Rapids 2, Mich.)

Circle 18 on Readers' Service card

Marker generator furnishes intensity-modulated time markers synchronized to the oscilloscope trace of the manufacturer's models 160B and 170A oscilloscopes. Marker intervals are 10, 1, or 0.1 μsec. Marker duration is a function of the adjustable intensity but is said always to be less than 40 percent of the marker interval. The markers may also be used to trigger external equipment. Wave form is a positive-polarity clipped sine wave with amplitude adjustable from 0 to 1 volt (peak) into open circuit. (Hewlett Packard Co., 1501 Page Mill Rd., Palo Alto, Calif.)

Circle 19 on Readers' Service card

Metering pump provides controlled flows from 0 to 158 ml/min with flow adjustable at any time. The pump is a diaphragm type; all parts coming in contact with the liquid being pumped are fabricated of chemically resistant plastic. Dimensions of the device are 9 by 10 by 7 in. Other models are available with capacities of 0 to 100 ml/min and 0 to 12.5 ml/min. (Cole-Palmer Instrument and Equipment Co., 7330 N. Clark St., Chicago 26, Ill.)

Circle 20 on Readers' Service card

Optical gage incorporates a precisely ruled scale as the measuring element. Accuracy is said to be $\pm$ 2.5 $\times$ 10^5 in.; range of measurement is 0 to 3 in. No correction for temperatures is required over the range 50° to 90°F. Maximum temperature correction over the range 31° to 105°F for a 3-in. dimension in steel is 0.0001 in.

The instrument is supplied with an anvil adapter that will accept a standard anvil or special fixture. A 3.5-in. diameter circular anvil and a 4- by 6-in. rectangular anvil are available as optional equipment. An optional foot-control switch frees the operator's hands for manipulating parts. (Bausch and Lomb Inc., Rochester 2, N.Y.)

Circle 21 on Readers' Service card

Computing audiometer combines a standard audiometer and typewriter, modified for audiological use, and a computing system said to be no larger than an over-night traveling bag. Simulating manual audiometry, the computer varies the frequency and amplitude of pure-tone signals in graduated steps and stores the patients' responses. Up to ten tests are given at any one frequency. If a response pattern is recognized before ten tests, the computer prints out the score and goes on to the next scheduled frequency. The computer can detect errors resulting from tension, tinnitus, or failure to understand instructions. If a pattern of errors is found that casts doubt on the validity of the hearing threshold, the data are discarded for that frequency and a question mark is printed on the audiogram. The computer can be programmed to follow any variation in techniques desired by the audiologist. (Beltone Hearing Aid Co., 2900 W. 36 St., Chicago, Ill.)

Circle 22 on Readers' Service card

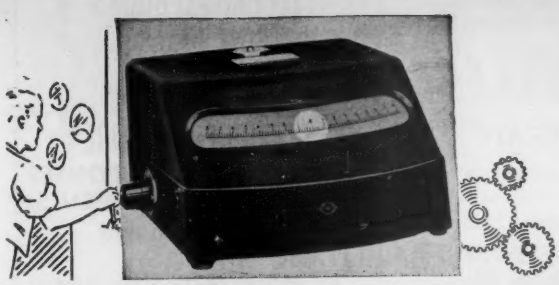
Cathode-ray tube for direct optical printing on light-sensitive materials uses fiber optics to conduct light from the phosphor to the atmospheric side of the face plate. Since the light is not dispersed in passing through the individual light pipes, the recording medium can be placed immediately adjacent to the face of the tube without supplementary optical systems. The tube is magnetically shielded and uses low-voltage acceleration, low-voltage electrostatic focus, and low-voltage electrostatic deflection. (Litton Industries, 960 Industrial Rd., San Carlos, Calif.)

Circle 23 on Readers' Service card

Cryogenic thermometer is designed for measurement in the liquid-helium range from 1.5° to 5.0°K. The temperature-sensitive element is a doped-germanium *p-n* resistor that measures approximately 235 ohms at 4.2°K. Sensitivity is said to be greater than 50 ohms per degree Kelvin at this temperature, and accuracy better than $\pm$ 0.050°K. The units are mounted in a glass-to-metal hermetically sealed platinum enclosure. Temperature is read from a calibration chart that can be provided with each thermometer element. (Radiation Research Corp., Westbury, N.Y.)

Circle 24 on Readers' Service card

Sonar depth ranger is designed to measure the distance from the ocean bottom of a grab, a coring tool, a camera, or other oceanographic equipment. Accuracy is said to be within 3 feet. The instrument can be attached at any point on the steel supporting wire between the ship and the equipment at the end of the wire. When lowered, it sends back two signals. One



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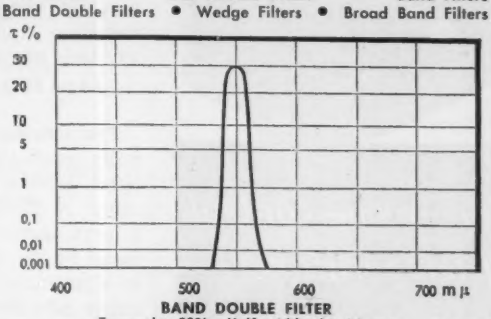

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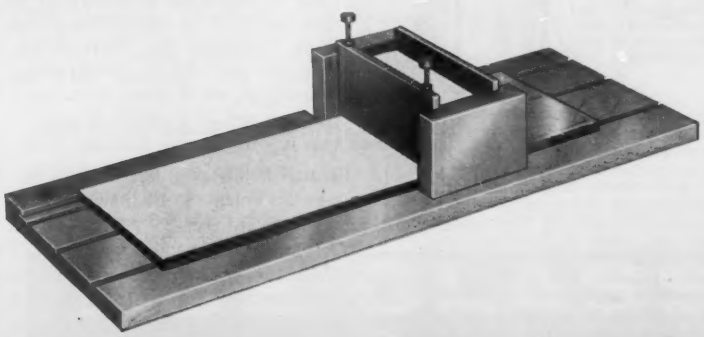
Experiments with different solvent systems may serve as a guide for application to columns on a preparative scale.

Bibliography on request.



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is direct and the other is reflected from the ocean floor. Comparison of the time required for the two signals to reach the receiving equipment provides the desired measurement of distance from the bottom.

The instrument is completely self-contained with its own batteries, electronic power, and control units in water-tight steel cases that are designed to withstand pressures of up to 9 tons/in^2. (Edgerton, Germeshausen & Grier, Inc., 160 Brookline Ave., Boston 15, Mass.)

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Photomicrographic camera automatically estimates exposure time, with either detail or field-integrating mechanisms. A multiplier phototube is used to sense illumination. The current produced by the tube charges a capacitor to a predetermined voltage. A gas-discharge tube then starts to discharge the capacitor operating a relay and opening and closing a vibration-free shutter. The film is then automatically transported by one frame. The self-contained 35-mm camera has interchangeable cassettes to hold any type of film desired. Interchange of magazines is said to require 2 sec. (E. Leitz, Inc., 468 Park Ave. South, New York 16, N.Y.)

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Photo sensor is designed to provide sensitivity to light-spot displacement. The device consists of an integral pair of similar silicon photodiodes. Its output is a differential electromotive force that measures the difference in light power incident upon its active cell surfaces. Characteristics obtained with a 2800°K tungsten source, quoted by the manufacturer as typical, include: light sensitivity of 250 mv at 50 mw/cm^2 and displacement sensitivity of 35 mv/mw per 0.001-in. displacement with a 0.02-in. diameter spot. (Micro Systems Inc., 319 Agostino Rd., San Gabriel, Calif.)

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Scratch depth gage (see Fig. 2) permits measurements to be made with accuracy said to be ± 0.0001 in. or ± 5 percent of depth, whichever is greater, for indentations ranging in depth from 0.0002 to 0.016 in. Scratch width can be determined to ± 0.001 in. from 0.001 to 0.050 in. The same ranges apply to the measurement of raised portions. The instrument operates by projecting an image of a wire of small diameter at an angle against

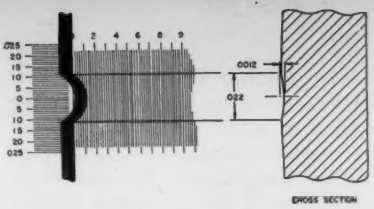

Fig. 2. View of scratch and projected shadow as seen through the eyepiece of a scratch depth gage.

the scratch. The operator views the distorted image against a set of scales. (Bausch and Lomb Inc., Rochester 2, N.Y.)

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Very-low-frequency receiver permits accurate calibration of local frequency standards by comparison with very-low-frequency (VLF) broadcasts from stations such as WWVL and NBA. The receiver may also be used for VLF field-strength measurements. Features include 1 μv sensitivity, five crystal controlled channels between 14 and 60 kcy/sec, a carrier level meter, and recorder output. The instrument is fully transistorized and operates from a-c line or battery. (Hewlett-Packard Corp., 395 Page-Mill Rd., Palo Alto, Calif.)

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Micro-hematocrit is a direct-reading, transistorized, battery-powered instrument. Operation is based on the insulating capability of red cells. A reading directly in hematocrit-percent units is said to be obtained in less than 15 sec from sampling to result. Sample size requirement is 0.02 ml of blood. (Yellow Springs Instrument Co., P.O. Box 106, Yellow Springs, Ohio)

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Recording titrator is an all-purpose automatic instrument with dual motor-driven titration assemblies, multiple direct-reading *p*H and millivolt ranges, and an automatic rate-sensing and adjusting system to prevent curve distortion in slow reaction systems. The instrument can be used for titrations in which the end points are determined either from the recorded curve or by automatic interruption of titration at predetermined *p*H or voltage values. (E. H. Sargent & Co., 4647 W. Foster Ave., Chicago 30, Ill.)

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JOSHUA STERN
National Bureau of Standards, Washington, D.C.

Letters

Voluntary Choice of Germ Plasm

H. J. Muller is to be congratulated on having bravely broached the subject of eugenics in his thought-provoking recent article, "Human evolution by voluntary choice of germ plasm" [*Science* **134**, 643 (1961)], and when thoughts are provoked strongly enough, I am likely to take up paper and pencil. I therefore would like to add my voice to what undoubtedly will be a chorus.

One can readily agree that genetic control should be used to eliminate the most obvious of hereditary diseases. It is further possible that genetic control could be used by a vicious dictatorship to increase the population percentage of the blond-haired and blue-eyed.

However, I do not think that our present state of knowledge of character traits is adequate to attempt selective development of certain traits over others. Even if one could agree upon the character traits desirable for human evolution, what guarantee could Muller give that the planned result would be achieved in the offspring? Bernard Shaw's famous reply to Isidora Duncan immediately leaps to one's mind.

Nevertheless, the day may come when future geneticists will have perfected genetic mapping to such an extent that they will be able to combine one sperm and one egg and predict precisely what kind of human being will result. Then, let us talk again of "human evolution by voluntary choice of germ plasm."

K. FLOREY
Squibb Institute for Medical Research, New Brunswick, New Jersey

I was shocked that H. J. Muller, a Nobel Prize winner, would write such an unscientific article in a journal titled *Science*. Muller's argument that individuals should voluntarily submit to artificial insemination in order to obtain the most desirable progeny is based on the indisputable notion that it would be nice to have the best possible nature for nurture to work upon. Once he leaves this rather obvious thesis, the whole article becomes a shaky collection of unproved assumptions. Witness the following.

1) What is the evidence that family size and low level of productive work have a genetic basis? In the few studies that have been made, how was the factor of environment controlled? What studies have been carried out to see what would happen if a large "white-trash" family were exposed to the best our culture can offer?

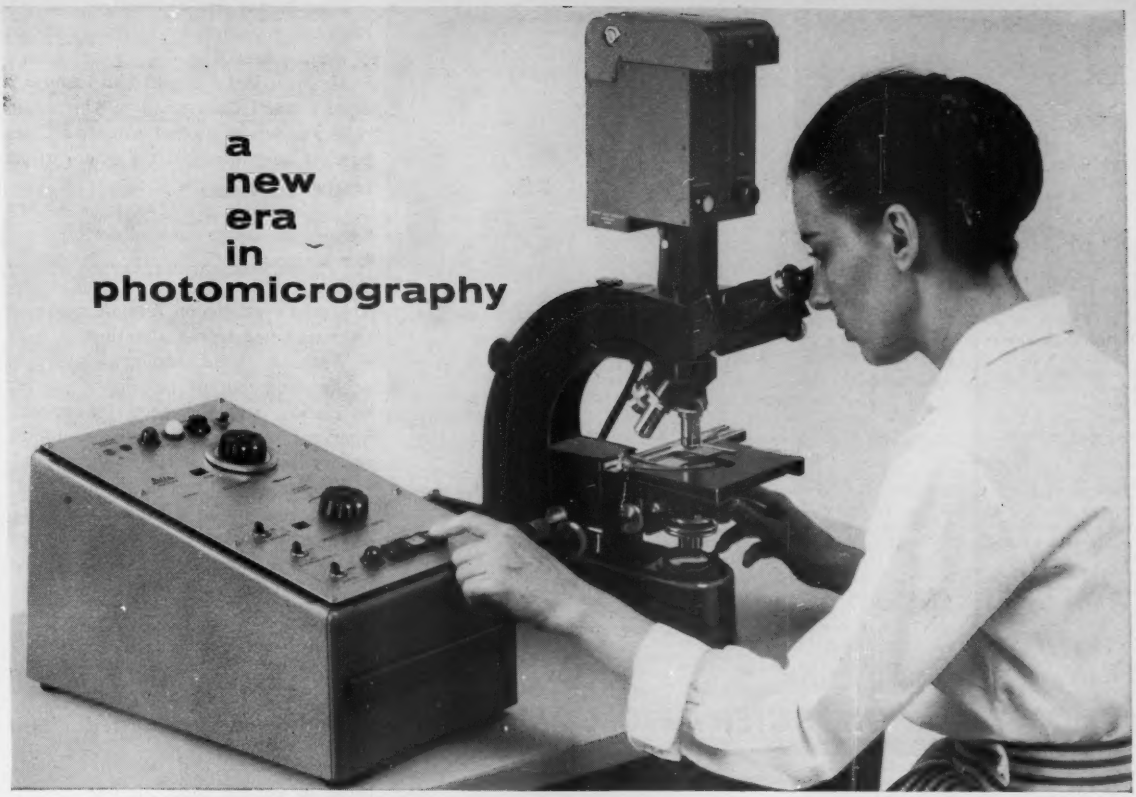
2) Muller states (p. 645), "A second proposal has been that of altering the economic and social system in such a way that people of higher gifts and greater natural warmth of fellow feeling—that is, the genetically more highly endowed—would be normally led into occupations and modes of life more conducive to having a large family." What are these "higher gifts" and what is "natural warmth of fellow feeling"? Have scientists agreed on the most desirable human qualities, and if so, is there any indisputable evidence that such traits are a genetic endowment? Obviously, Muller assumes so, but recent work on such a well-agreed-upon standard as the I.Q. suggests that the genetic component may have been overrated. Indeed, Passamanick (who believes that schizophrenia is genetically caused) has recently suggested that his studies show the human brain to be so highly adaptable that the lower end of the I.Q. scale is related not to heredity but to opportunity—including the circumstances of birth and early rearing.

3) If Muller thinks that the fathers of children produced by artificial insemination don't have problems arising from their lack of biological participation, he hasn't spoken to many psychiatrists. But even assuming that this isn't a big hurdle in Muller's plan, I must question his statements (p. 646) that "in this connection, it is important to bear in mind that there is no such thing as a paternal instinct in the sense of an inherent pride in one's own genetic material or stirps." Although chimpanzee males recognize their infant progeny, I would grant that there is no good evidence for an inborn instinct for being a papa in the human male. Is there scientific evidence that there is an inherited instinct in the human female to be maternal? Muller tries to sell us on the notion that nonbiological offspring present no problems not presented by biological ones and, indeed, offer some advantages. This is, I submit, because he is interested in selling his plan and not because he knows of good evidence in support of this conviction.

4) Muller states (p. 648) that it is true that we have next to no knowledge of genes for those traits "we value most. . . ." He then goes on to state, "However, [this] has also been true in all the natural selection of the past and in the great bulk of artificial selection. Yet these empirical procedures, based entirely on the accomplishment of the individuals concerned, did work amazingly well." It appears that Muller knows of proof that children created by artificial insemination are better products than those conceived naturally. The one impressionistic study he refers to cannot seriously be taken as evidence for the whole problem, even if one acknowledged it was possible to obtain a truly random sample of all individuals who have been produced by artificial insemination. Those individuals that I come in contact with who have an offspring conceived by artificial insemination do not tend to advertise it.

Even if Muller could establish what were the desirable traits, and further establish that these had important genetic linkages, I wonder if he wouldn't find himself in Frankenstein's shoes. Given the best possible breed of men—intelligent, fearless, and strong—who would be willing to go to the bottom of the class? In any group structure there has to be hierarchy in order to achieve function. Would superior beings born to India's socio-economic problems solve them, or might they not grow apathetic despite their high genetic endowment? In short, science has a great deal of work to do before Muller's proposal can be considered in any kind of meaningful context.

DON D. JACKSON
Mental Research Institute, Palo Alto Medical Research Foundation, Palo Alto, California



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Hurrah for H. J. Muller's article, "Human evolution by voluntary choice of germ plasm"!

My wife and I would like to have a child whose father would be Albert Einstein and whose mother would be Cleopatra. Can you advise me where to get the necessary?

VERNER W. CLAPP
Council on Library Resources, Washington, D.C.

Muller's article on human evolution has just come to my attention.

While I salute Muller's forthright acknowledgment of hereditary psychic differences and the need for eugenic intervention, I cannot help questioning the method he proposes. It seems hardly likely that nature will submit tamely and indefinitely to a permanent fraud —and what other word could be used to describe a systematic deception of instinct? After all, sexual pleasure and attraction and the desire for and love of progeny are adaptive, or they would not exist. Remove their proximate basis, and these feelings, too, will in time disappear.

In his rationalistic scheme Muller assumes that men and women will continue to choose their mating partners by, among other things, "sexual love," even though the act of procreation will have lost all meaning. He assumes that the procreative organ of the "superior" male will obediently continue to yield up its precious genes in response to loveless, mechanical stimulation. He assumes that "parents" will continue to shower love and affection on preadopted children who are strangers to them emotionally, intellectually, and physically. He assumes all this because man "has a right to depart from the haphazard method . . . of natural circumstances."

He may have the right (conferred by Muller?), but does he have the power? I think not.

H. GEORGE CLASSEN
420 Hinton Avenue, Ottawa, Canada

H. J. Muller states, "there is no physical, legal or moral reason why the sources of the germ cells used should not represent the germinal capital of the most truly outstanding and eminently worthy personalities known." This statement is true enough if use is distinguished from abuse. However, Muller seems to overlook this fundamental distinction. He wishes to allow a "salutary separation" of the promotion of genetic quality from the choice

of conjugal partner and the consequent determination of the size of the family. Such a separation, far from being "salutary," would be destructive of the natural basis of human society. This basis is clearly acknowledged by Muller when he says, "It is . . . 'first nature' for men and women to be fond of children and to want to care for them, and more especially, those children with whom they have become closely associated and who are dependent upon them."

The firmest bond between parents and children is the physical bond established by choice of the conjugal partner and use of the conjugal act by which the children are generated. Abuse of the human way of generating a family may induce legislators to place legal obstacles in the way of a practice which destroys paternity and deprives the child of a natural father with a father's rights and duties based on the physical bond. Indeed, the physical bond by which parents and child are most intimately associated and by which the child is dependent upon the parents both for being and for well-being in this world is the natural foundation of the moral requirement that genetic quality be promoted through the choice of conjugal partner and consequent determination of the size of the family. This way may not be perfect from every point of view, but it is clearly the best. "What God has joined together, let no man put asunder."

WILLIAM H. KANE
Albertus Magnus Lyceum,
River Forest, Illinois

I wish to point out what seems to be an inconsistency in Muller's article. Speaking of the advent of improved contraceptive procedures (p. 645), Muller states, "Still more practicable means of contraception seem at last to be on the way, thanks to the efforts of a handful of devoted scientists, and they cannot come too soon, for it is imperative to make similar benefits possible in the less developed [geographic] regions."

If one accepts the argument that civilization as it advances is nullifying the beneficial genetic aspects of natural selection (and the truth of this premise is implicit in Muller's whole proposition), then it is quite clear that the least developed areas are the source of the world's best genes, for it is there that mortality is enormous, and the most fecund societies are barely holding their own. Furthermore, these areas are the least affected by the negative

genetic influence of civilized warfare and atomic radiation.

I would like to suggest that until such time as society is prepared to deal with eugenic problems in a proper scientific manner, nothing be done to disturb this reservoir of superior genes.

THEODORE D. PERRINE
1103 Lewis Avenue,
Rockville, Maryland

Both Florey and Jackson question the possibility of agreeing on "the most desirable human qualities." It is true that in exercising germinal choice, just as in framing the pattern of a child's education, the making of value judgments by his elders is a basic prerequisite. In both areas their responsibility is increased, not diminished, by the need for making such judgments, and the most serious deliberation is called for. Fortunately, however, most human beings practically everywhere have already attained the stage where they recognize the primacy for humanity of the major social proclivities and intellectual faculties, as well as of physical well-being. And although they will of course make mistakes, it is in general possible for them to recognize not only gross defects in these respects but likewise, at the other end of the scale, exceptional excellence.

On the other hand, anything like complete agreement is as undesirable as it is impossible in such an open-ended situation, and this is a major reason why the choices should be voluntary, not imposed. While Jackson might promote his seemingly Napoleonic ideal of "the intelligent, fearless, and strong," who wants to be top dog "in the class," and might continue to question the very existence of natural warmth of fellow feeling and of maternal affection, nevertheless it is to be anticipated that the ordinary citizen who is idealistic enough to engage in germinal choice at all will tend to favor a more sympathetic, otherly-oriented yet creative type. Moreover, later generations can be guided, in their future choices, by comparing the fruits of these different judgments.

The same two critics also question the effectiveness of any such selection in achieving the ends sought. As I stated in my article, "there is always an enormous amount of uncertainty concerning the outcome in . . . so cross-breeding an organism as man, especially since the most important traits of man are so greatly influenced by his cultural environment." It is wishful thinking to believe that the progress of genetics can greatly reduce this uncertainty in the foreseeable future, with regard to traits of positive value. Those who elected to engage in germinal choice would realize in advance that this uncertainty applies to every individual case. But they would prefer this risk, as being a much lesser one than that which usually attends the ordinary course of reproduction. And the resultant over-all trend would be in the direction that most of them had chosen.

At the same time, those who still held the naive belief that heredity plays little or no role in the determination of individual differences in man would of course continue to procreate in their own way. But it would be highly inconsistent of them to regard the exercise of germinal choice on the part of the others as endangering the genetic constitution of the population. It is a bit late in the day, however, for anyone still to disregard the evidence for the importance of genetics in the determination of individual differences in respect to either the physical, the intellectual, or the emotional make-up of human beings.

Classen does not question the genetic basis of parental and sexual emotions but fears that this basis will eventually wither when the activities these emo-

tions lead to are diverted toward somewhat different objectives. He should recognize that loss does not follow disuse directly in the Lamarckian way but only in consequence of the relaxation of selection. However, when the selection is artificial, it tends to follow the objectives of those making the selection. The great majority of people probably value and recognize the importance of both the parental and the sexual drives in the formation of well-rounded human personalities and in the orientation of people's striving toward worthy achievement and humane living. But even if they did not recognize this connection they would tend to base their selection upon criteria of character and accomplishment not likely to be met by persons who were ill equipped in these emotional respects. For these drives no longer serve only their original ends but have become basic to much else in human functioning.

Classen, Kane, and Jackson all make the mistake of assuming that children who are pre-adopted are (to quote Classen) "strangers [to their elders] emotionally, intellectually, and physically." Surely it is a calumny on humanity to assert (with Kane) that "the firmest bond between parents and children is the physical bond." As Calvin Kline once put the matter in a personal communication, the product of man's brain and heart, engendered through his conscious choice and exerted in the interests of the child himself, enlists his devotion as deeply and as truly as the product of his loins. And how can we decide, on the mere basis of what is "natural," which morality is the higher, so long as all man's living is a turning of the artificial into the natural? Of course Jackson can point to some foster parents and adopted or pre-adopted children of today who are ashamed of their situation, but that is because the parents had not embraced the new morality; they had simply been involuntarily inadequate, and they and their physician had carried out the whole transaction in an atmosphere of guilt. In contrast to this, follow-ups of cases conducted in a better spirit—which, however, are also kept secret, in compliance with present mores—have given evidence of highly gratifying results.

Perrine appears to grant my argument [given more fully in *Perspectives in Biology and Medicine* (Autumn 1959) and, along with discussions by others, in *Daedalus* (summer 1961)] that modern civilization, when associated with our present reproductive

mores, is genetically debasing. However, he makes this into an argument for letting the technically underdeveloped peoples remain underdeveloped, in order to conserve their genes, rather than joining in my plea for higher mores of reproduction. If he really believes in his thesis, why does he not recommend that we abandon our machine technology and higher living standards so as to conserve our genes also? Or does he realize that if we manage to hold back technological development elsewhere, instead of aiding it, we ourselves will inevitably become engulfed in the overflowing global ghetto, and that the solution he proposes will thereby be arrived at throughout the world?

The only rational and humane position is quite the contrary. That is, the avoidance of world catastrophe demands the extension of technology everywhere, and its application not only to production but also to reproduction. The latter measure involves, most urgently, the effective quantitative limitation of population, and it also involves, no less inescapably in the long run, the adoption of mores and techniques that recognize the importance of genetic quality and permit its enhancement by voluntary means.

HERMANN J. MULLER
Department of Zoology,
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Public Opinion in the U.S.S.R.

"You Americans don't know anything about the Soviet Union. You think bears still wander the streets of Moscow." How many times we heard this in Russia!

How right the Russians were is brought out by K. B. Krauskopf's article in *Science* [**134**, 539 (25 Aug. 1961)].

Krauskopf's discussion of Soviet public opinion seems both true and shocking, as for example in the fact that Russians believe: "How happy the world could be, if only America weren't so belligerent!"

But in other respects one sees in this article an American scientist, not specifically trained in Soviet politics, taken in like many American tourists. They resemble Catherine the Great, impressed by a few model villages her minister Potemkin wanted her to think were typical of the whole Crimea.

Krauskopf reiterates what high-rank-

ing Soviet scientists told him, and—despite the fact that their line was identical with what any Soviet Intourist Guide is trained to tell foreign visitors—he accepts this story as the real beliefs of these men.

Students, journalists, diplomats, and others who have lived in the Soviet Union know that many, if not most, Soviet citizens have serious reservations about the Communist regime. But these views are confided to foreigners only after a long period of trust and friendship. No Russian, particularly one with a good job, will risk his future by idle talk with foreigners.

Three of Krauskopf's assertions conflict harshly with the facts.

1) "That freedom of speech now exists in Russia is amply attested by our conversations, which were held in public places as well as private, and always without the slightest show of apprehension. . . . Neither the Russians nor I had any idea at the time that these impressions would ever be written down."

Of course, if Soviet scientists sit down and regurgitate only the Intourist line, they have nothing to fear from their government (or their colleagues, who could report them). Further, they could even expect to be rewarded for their loyalty to the regime. But in dormitories, in shops, in restaurants, and even in their homes, Soviet people still close the doors, turn up their radios, and speak in low tones when they say anything which deviates slightly from the official line. The possible penalty if they are caught? Expulsion from the Young Communist League, their school, or their job or possible arraignment on false charges.

Krauskopf says there are only common criminals in Soviet labor camps today. However, Russians will tell you that the men earlier convicted of political crimes are now simply relabeled thieves and are continuing to serve time.

And when Krauskopf says there is no fear of arbitrary arrest in Russia, he may be referring to his geologist friends, who are away exploring virgin forests; he cannot be talking about big cities, where we have seen children whisked away in police cars for talking with foreigners.

2) Krauskopf says his geologist friends have "a deep enthusiasm for communism." They have "a sense of mission . . . of being part of a progressive movement that will make the world a better place."

No doubt there are missionary idealists in the Communist as in the Christian world. But Russians themselves, coming from all walks of life, will tell you that the people, particularly the young people, aren't what they used to be. In the 1930's the Young Communist League volunteered to build the Moscow subway. But Russians today—much like the Americans—are mainly interested in a secure job, a nice home, and TV, a major difference being that they watch soccer instead of baseball! Many Soviet geologists, far from being missionaries of communism, are known to have taken up geology so they could escape the big-city politicians who molest the lives and study of laboratory scientists.

Many Russians agree that Soviet brains and imagination go first into mathematics, physics, and chemistry and last into economics, philosophy, and history. It is the former group which questions the old party doctrines and the latter group which attempts to refute mechanically the "revisionists'" ideas. "We need new forms of art and literature to express the complexities of

the new world we're discovering," scream the physicists in public debates. But the philosophy students, whose careers will be in high school teaching of Marxism answer merely with dead dogmas.

Geologists are a breed unto themselves, as bright perhaps as physicists, but more rugged and individualistic. After hours, the physicist may attend a concert, whereas the geologist hunts Siberian bears or climbs mountains in Central Asia.

3) Krauskopf's "acquaintances seemed quite sincere in regarding [the Soviet] way of choosing candidates as actually more democratic than the American method."

This was seemingly true of Soviet students forced by their Young Communist League to go from door to door urging the workers in the city to go to the polls early on voting day. But—as many students told us—the whole process is a farce, because there is but one candidate on the ballot. The voter can cross out the candidate's name and write in another, but this is a futile and risky business.

Even ardent Communists told us—when they believed they weren't overheard—that they look forward to "free elections" some day in Russia. Americans in Russia in 1936 heard rumors that the new Stalin Constitution that year would provide for more than one candidate at elections. It didn't, however, and nothing more hopeful has appeared officially than the new Communist Party Program, which looks forward to the "dictatorship of the proletariat's" changing to a "state of the people."

If one meets Soviets on something more than a one-shot, semiofficial basis, he gets an impression very different from Krauskopf's. He learns that the Russians' ideas are more like the Americans' than Krauskopf suggests. The Russians' system of government, however, is not.

The U.S.S.R. is a long way from having freedom of speech, freedom from arbitrary arrest, free elections, and even equality of opportunity.

None of this means the Soviet Union is ripe for revolution. Most Russians are basically proud of their country and scientific achievements. This pride is one reason for the Soviet citizen's reluctance to criticize his government in front of foreigners.

But Russia is ripe for reform—from within—and the Soviet government and people know this!

WALTER C. CLEMENS, JR.
DIANE S. CLEMENS
Department of Political Science, University of California, Santa Barbara

The sagest remark I have heard about the conflicting reports that visitors bring back from the Soviet Union is the simple statement, "Everything you hear about Russia is true." The country is so large and complex that almost any reported observation may well be true in some degree or for some part of the population. I have no doubt that the Clemenses' descriptions of Russian attitudes are accurate, and I welcome them as an antidote to the quite different impressions I received. To build up a reasonable picture of the Soviet Union requires, I am convinced, that we piece together fragmentary bits of information from many sources. The Clemenses' observations should very probably be given more weight than mine, because they have made a special study of Russia. They have toured the country on several occasions, and Dr. Clemens has spent a year as a student at Moscow University. The Clemenses also object quite properly that I am a scientist ven-

turing to express opinions in a field where I have no special competence.

Nevertheless, I feel that their scorn for my unbounded naiveté is a little extreme. I would grant immediately that much of what my geologist friends told me is similar to the current Communist party line. Does it follow that my friends were necessarily being hypocritical? I have heard Intourist guides in action, and I have heard some geologists who sound like them—parroting stock answers to questions, with minds closed to argument, obviously unwilling to trust a foreigner with their real thoughts. But this is altogether different from the long and intimate discussions I had with men whom I learned to know over periods of several days. We explored various issues thoroughly, with no holds barred; sometimes they would score a point, and sometimes they would concede that I had picked on a weakness of their Communist regime. The "enthusiasm for communism," which so horrifies the Clemenses, was a commitment to the basic tenets of communist ideology, but it did not prevent my friends from admitting, and even pointing out voluntarily, weaknesses in governmental procedures and problems that the Communists have not yet solved. How, after all, does one tell when one's companion is being sincere? Is he sincere only, as the Clemenses imply, when he whispers dissatisfaction with his government under cover of a blaring radio? It may be—I can't really prove it otherwise—that I was continually hoodwinked by clever agents instructed to deceive me, that every Russian can by second nature "smile and smile and be a villain." To show why I believe differently would require a tedious cataloging of little incidents of interpersonal relationships. Tedious also would be a recitation of the many ways in which my activities did not follow a prearranged official plan—as the Clemenses imply they did by comparing them with the Crimean tour of Catherine the Great. One of the chief reasons I felt that my observations might indeed have some validity was the fact that (outside of the carefully prearranged official visits to laboratories and institutes) so much of what happened was entirely spur-of-the-moment, following either my whims or those of my companions.

The Clemenses are so eager to discredit me that they permit themselves some deliberate misquotations. For example: "Krauskopf says there are only

common criminals in Soviet labor camps today." Krauskopf did not, and never would, make any such statement; he quoted it as the opinion of two geologists, and at the end of the paragraph specifically emphasized that he had no direct information as to the truth of the assertion.

Again, regarding electoral procedures, the Clemenses have apparently willfully misunderstood me, in order to make their point that some ardent Communists yearn for free elections. It may well be true—I should be surprised if it weren't—that some Communists would like to see free elections in their country, but the point I tried to make was that in the eyes of my acquaintances the democratic process operates during the choosing of candidates in the assemblies (Soviets), not in the official balloting.

If I am to be accused of naiveté, I can perhaps claim with equal justice that the Clemenses have fallen victim to the all-too-familiar American stereotype: Russians resemble Americans; Americans don't like communism; hence Russians can't really like communism; and therefore we may infer a deep general resentment from the few examples of Russians who are willing to express their dissatisfactions to us. For as long as I can remember (and I think my memory goes back considerably further than the Clemenses') I have listened to would-be Russian experts describe the unhappiness and smoldering resentment within the Soviet Union. For years I have seen our newspapers magnify every hint of economic difficulty, every local flare-up of workers or peasants. And yet the Soviet Union, despite monstrous mistakes of its government, has grown steadily more prosperous; it has fought a bitter war and emerged stronger than ever; and under its influence communism has spread to one part of the world after another. This does not impress me as the work of a sullen, unwilling populace. It seems a reasonable inference, however unpalatable it may be, that communism has a genuine appeal to a large number of people; and it might be more realistic if we would accept this and try to see wherein the appeal lies, so that we can combat it, rather than delude ourselves with wishful thinking about the extent of popular dissatisfaction.

Regarding the validity of the Clemenses' conclusions about one segment of Russian opinion, there is no question in my mind. But I fail to see what pur-

pose is served by their vicious attack on observations of a group of Russians different from those in the circle of their acquaintance. The views I recorded were not the only ones I heard, but those that stood up under reasoned argument and that formed a pattern consistent with Communist ideology. They were expressed with every show of sincerity. We cannot agree with these opinions, of course, and we need not believe that their supposed factual basis is wholly correct. But as expressions of the way of thinking of one group of Russians, they should hardly be branded as false merely because they differ from the views expressed by the Clemenses' more critical Russian friends.

KONRAD B. KRAUSKOPF

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Dynamic Teaching

Probably few college teachers or others will take exception to a conclusion reached in the editorial "The system" [*Science* **134**, 159 (21 July 1961)] that more than lip service should be accorded the proposal that teaching be made an even more rewarding career than it now is. However, an unfortunate fallacy is evident in the argument, in my opinion. The fallacy lies in the sharp distinction made between "teaching" and "research" at the university level. If "teaching" is rated "second class" by "the faculty," it may be because of the image of a stagnant pedant evoked by the term *teaching*.

Is it necessary to relearn constantly that students learn by their own efforts? Usually these efforts to learn (by listening, by talking, by reading, and, most trying, by writing for the consideration and criticism of others) can only be stimulated to a greater or lesser degree by teachers. Teachers who feel that they are still learning and who are as enthusiastic about the work of others in their discipline as they are about their own contributions are more apt to make the classroom situation the dynamic one that it should be.

Perhaps the hardest types of work men can do are to think and to submit their thoughts in writing; to observe and then to report accurately their observations. To carry out these processes with "students" is a learning and teaching process for all concerned.

For a detailed look at the other side

of the sombre picture drawn by the writer of the editorial—that is, at the invalidity of separating research from college teaching—one cannot do better than to read the article by Charles A. Fenten in the *Bulletin of the American Association of Professors* entitled "The sweet sad song of the devoted college teacher" [**46**, 361 (1960)].

STANLEY MARCUS
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Keynes' Theories of Economics

In recent issues of *Science* considerable space has been given to a writer who has been consistently glorifying the policies being announced by the current administrators of the federal government. He has been praising the applications of Keynes' theories of economics being made by those administrators. Particularly he has been stressing the belief that these "cheery" theories will provide a remedy for the problems of unemployment in the United States.

In appraising this writer's reports, scientists may wish to consider the statement [*Science* **128**, 1610 (1958)] of Harvard's outstanding economist, the late Sumner Slichter, that ". . . technological research had developed sufficiently by 1937 to make Keynes' theory of employment obsolete on the day of its publication. . . ."

H. C. TRIMBLE
25 Shattuck Street, Boston, Massachusetts

Strontium-90 in Wheat Flour

An interesting possibility that a substantial fraction of strontium-90 contamination in wheat flour in 1960 arose from wind-blown soil particles adhering to the head of the wheat plant has been raised by Ichikawa, Abe, and Eto in their report in *Science* [**133**, 2017 (1961)]. This possibility does not seem consistent with their data.

They considered that the apparent direct absorption of strontium-90 into wheat flour in 1960, compared with that in 1959, was too large to be accounted for by current fallout, since the fallout rate while the wheat heads were exposed was only one-fifth of that during the comparable period in 1959. However, if their data on strontium-90

contents of wheat leaf, husk, and bran are treated in the same way as the data for wheat flour, it is seen that the direct absorption of strontium-90 into the leaf and bran is consistent with the decreased fallout rate, while absorption into the husk agrees with the result for flour. If absorption of strontium-90 from wind-blown soil particles is a factor, then the content in husk, bran, and flour should all have been affected in the same way.

These calculations require the questionable assumption that the fraction absorbed by the wheat plant is constant from year to year. The retention and subsequent absorption of fallout probably varies greatly with the time and intensity of rainfall in relation to the age of the plant.

RONALD G. MENZEL
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My associates and I find Menzel's criticism very important and instructive. Though the contribution of wind-blown soil particles to the strontium-90 content in plants and the physiological mechanism of the phenomenon are not yet clear, it seems that the contribution of the soil particles does not necessarily affect the various parts of the plant in the same way. For example, at the time of ear shooting, husk and bran have already completed most of their growth, but the tissue which will eventually become wheat flour does most of its growing after ear shooting. Therefore, it seems likely that the strontium-90 derived from a soil particle that has adhered to the ear can be effectively incorporated into the "flour" tissue during its growth, together with other nutrient minerals. After the increase in mass of the "flour" tissue and the subsequent death of the husk tissue, rainout activity and direct absorption of strontium-90 become dominant factors, affecting the bran much more than the "flour" tissue. Therefore, the contribution of soil particles to bran can be assumed to be much less than the contribution to flour. Of course this is a possible assumption, though the mechanism would be more complicated. The phenomenon should be investigated further.

The relationship between fallout activity and contamination levels in plants has been utilized for analyzing food-chain contamination due to fallout. Of course, the influence of the rainfall pattern and the growing stage of the plant should be taken into consideration for the analysis. But it seems possible to assume that the rate of direct absorption of current fallout activity from year to year does not vary so much, if the same crops, harvested in the same season, are used.

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Water Resources

A recent issue of *Science* [**134**, 658 (8 Sept. 1961)] carried a brief item, "Salt-free water," which states that an "economical method for converting sea water to fresh water would be immensely useful for this country, *which faces a water shortage in the decades ahead.* . . ." (italic mine). Appearing as it does in a scientific journal, this statement would seem to sanction the claims of the water-supply alarmists that the United States will run out of water within the next 40 years.

There is no disagreement over predictions of a steadily increasing use of water in the decades ahead, but the prophets of desiccation of our water resources imply that water used is water used up. A conservative estimate indicates that our net need for water will be about 117 billion gallons per day by A.D. 2000, or 18 percent of the supply likely to be available by that time on a sustained-yield basis. The Select Committee on National Water Resources published a figure of 156.3 billion gallons per day, based upon similar assumptions.

An increasing use of water means merely a greatly increased *reuse* of water. This reuse will require improved methods for in-plant recycling of water, and for treatment prior to final discharge to protect the interests of downstream users. Thus, the cost of water and of waste treatment will rise, but there will be nearly as much water available as there ever was.

Research on desalting ocean and brackish water is an important federal project, but it should be evaluated in proper perspective. An economical method for recovering fresh water from the ocean would be an undoubted boon to water-short areas, but it is illusory

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RICHARD D. HOAK

Mellon Institute, Pittsburgh, Pennsylvania

Racism and "The Mankind Quarterly"

In *The Mankind Quarterly* there appeared, some time back, an article by Henry E. Garrett (*1*) entitled "Klineberg's chapter on race and psychology." It constitutes an unwarranted criticism of Klineberg's pamphlet *Race and Psychology*, published by UNESCO in 1952 (edition 2, in English, 1956). Garrett departs from the main theme to make various assertions about the biological, mental, and moral "inferiority" of Negroes and about the obvious degeneration of mixed-breed groups.

To quote from Garrett's review (*1*, p. 21): "The weak, disease-ridden population of modern Egypt offers dramatic evidence of the evil effects of a hybridization which has gone on for 5000 years. In Brazil, coastal Bahia with its negroid mixtures is primitive and backward as compared with the relatively advanced civilization of white southern Brazil. In the West Indies, the civilization is advanced almost exactly in the degree to which the populations are unmixed with the Negro. Haiti is an unhappy example of what the Negro can do when left to govern himself."

And from page 22 of the same article: "Klineberg states flatly that 'no racial factor has been discovered to be responsible' for crime. As usual, the fault lies in the social environment. Undoubtedly social factors *are* important, but it is hard to see how such influences can excuse the literally scandalous crime rate of the Negro in the United States. In 1954, the FBI reported (Dept. of Justice, Vol. 25, No. 2) the following ratios of Negro to white crimes: For murder, the Negro/white ratio is 16:1; for robbery, 13:1; for prostitution and vice, 16:1; for rape, 6:1. These ratios hold despite the fact that the Negro constitutes only 10% of the general population. *It requires a degree of*

imagination not possessed by the reviewer to see no 'racial factor' in these figures" (italics mine).

These and many other statements of the same tenor which appeared in Garrett's review prompted the just reaction of several anthropologists. Biological racism, to judge from the first issue of *The Mankind Quarterly*, is being revived, with arguments as feeble as they are erroneous; the harmful effects of unscientific racism during the past decades are only too well known.

The reaction, as qualified as it is moderate, to Garrett's paper, may be read in Skerlj (*2*) and Comas (*3*).

Now the second issue of *The Mankind Quarterly* has appeared. The editorial therein, commenting on reaction to the magazine, includes the following:

"A few abusive letters have, however, also been received, although their numbers are negligible in comparison with those which have expressed pleasure at the production of *The Mankind Quarterly*. Whatever the status of the writers of these letters, they can be considered little better than cranks."

No names are given, but undoubtedly the comments are directed to those anthropologists who are not in accord with this resurgence of racism. Certainly the well-established scientific standing and personality of the two authors mentioned above (Skerlj and Comas) cannot logically be associated with the assertions in the editorial.

There is no question that in the field of science opposing points of view arise, because of differences in knowledge or background or because of adherence to schools based on different interpretations of the same data or on premises which cannot be harmonized, and so forth. However, this is not the case here. Racial differences exist. These differences should be and are being studied. A whole branch of anthropology is concerned with this study in an effort to determine what the differences are and how they may be used—to understand them from every possible angle (genetic, morphological, social, and so forth) but always within the framework of serious and scientific investigation. The 1952 UNESCO Statement on Race is quite clear on this point.

There is such a thing as freedom of research and freedom of teaching. What should not be allowed is what *The Mankind Quarterly* has set out to do—that is, to use science, or rather pseudoscience, to try to establish postulates of racial superiority or inferiority based on

biological differences, when the traits may prove to be good or bad, advantageous or not, depending on the environment in which they exist and the purpose and end they serve (*4*).

I am now formally addressing *Science*, as the official voice of the American Association for the Advancement of Science, to ask that the Association urge the scientists who are accessible to it (I would suggest, among others, Medawar, Haldane, Simpson, Huxley, Neel, Wright, Dunn, Dobzhansky, and de Beer), United States citizens or not, to take action, in the name of the Association, against this unwelcome, ill-founded, unbiological outgrowth of racism (*5*).

The purpose of this note is not to initiate a discussion of whether or not there are scientific bases for establishing racial differences of biological order which carry concepts of superiority or inferiority. What is known about adaptation, genetics, mutations, or selection today refutes the a priori views of those who, like Garrett, are intent on maintaining pseudoscientific racism. I have no other purpose than to denounce this attitude of men of science who, with strange antiscientific spirit, distort facts, as Archbishop Wilberforce did a century ago, when he was so well exposed by Thomas Huxley in the memorable Oxford session on evolution.

It seems pertinent, therefore, to quote, however briefly, from a few scientists whose views contrast with Garrett's position.

Medawar (*6*) wrote: "Attempts at selection are, in fact, torn between conflicting interests: the characters we are hoping to establish and fix in the population—height or weight, perhaps, or, in the fruit-flies that are so often used for these experiments, bristliness—may well find their most extreme expression in the true-breeding homozygous form; but that is not going to be much consolation if these homozygous forms are inferior in fitness, and are therefore at constant disadvantages compared with the forms that do not breed true. Artificial selection and natural selection pull opposite ways." That is, as Hulse (*7*) has clearly stated, the concept of race, to have any scientific utility, must be based on genotype rather than on phenotype.

I quote now from Caspari (*8*): "Heterozygotes frequently have adaptive values superior to either homozygote. This phenomenon of 'heterosis' makes it possible for two alleles to remain in a population, and in this way maintains the genetic variability and adaptability of population. Heterosis is frequently expressed in a lower phenotype variability of heterozygotes."

Penrose wrote:

"No genetical evidence has so far appeared to indicate that the human race is not all one species. In other words, unions between males and females from any different national geographical or cultural groups can all be fertile and their offspring normal. Matings of Europeans, Africans, Americans, Indians or Oceanics with all kinds of Asians are biologically successful, as indeed are crosses between these groups. . . . (*9*, p. 121).

"In the case of 'race mixture,' therefore, the result is just that we get a new or unusual combination of alleles at a number of different loci; there is no theoretical reason why such new combination should be disadvantageous. . . . (*9*, pp. 121–122).

"It is clear from the trend in recent decades that, in future, more and more mixtures of the older, isolated, human groups are to be expected. The result

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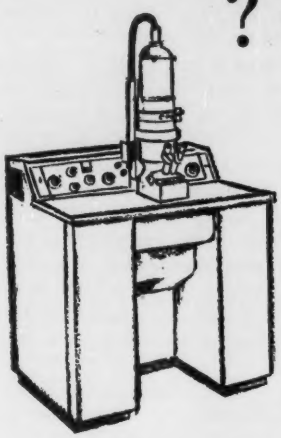

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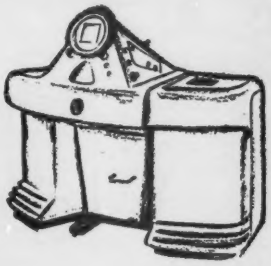

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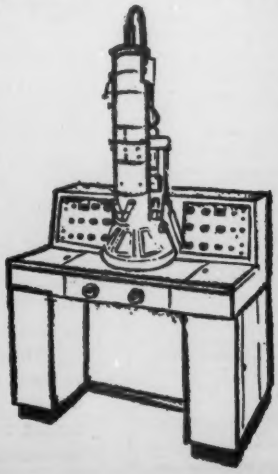

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will be an increase of variety within populations for many generations, in the sense that many new combinations of genes will be produced. On the whole this can be regarded as a favourable development because it will increase the number of man's possible inborn reactions, whether physical or psychological, to his rapidly changing civilized environment" (*9*, p. 122).

Finally, from the 1951 UNESCO Statement on Race, signed by 14 eminent geneticists and anthropologists, I quote the following:

"Furthermore, so far as it has been possible to analyze them, the differences in physical structure which distinguish one major group from another give no support to popular notions of any general 'superiority' or 'inferiority' which are sometimes implied in referring to these groups" (p. 12).

"Studies within a single race have shown that both innate capacity and environmental opportunity determine the results of tests of intelligence and temperament, though their relative importance is disputed" (p. 13).

Should all the scientists, then, who subscribed to the 1951 Statement on Race, and also Skerlj, Comas, Medawar, Simpson, Penrose, Caspari, and others, be considered "little better than cranks"?

Indeed, *The Mankind Quarterly*'s attitude is so harmful that I hope the AAAS takes some action.

Note added in proof: While this letter was in press, the July–September 1961 issue of *The Mankind Quarterly* (**2**, No. 1) has appeared. In it the same extreme racial trend is followed. Among other papers, it contains a review by A. James Gregor of Comas's *Racial Myths*—a review which is full of totally unjustified personal attacks and insinuations of a political type, without basis and completely outside the framework of the problem under discussion.

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References and Notes

1. H. E. Garrett, *The Mankind Quarterly* **1**, No. 1, 15 (1960).
2. B. Skerlj, *Man* **60**, 172 (1960).
3. J. Comas, *Current Anthropol.* **2**, 303 (1961).
4. Another article by Garrett, "The equalitarian dogma," appeared in the April 1961 issue of *The Mankind Quarterly*. It was reproduced in *Perspectives in Biology and Medicine* [**4**, 480 (1961)] and in the *Negro Digest* [**12**, 38 (1961)]. It has been unfavorably commented on by M. J. Herskovits in the *Negro Digest* [**12**, 43 (1961)], and by G. A. Harrison in *Man* [**61**, 189 (1961)].
5. I cite two examples of action taken in the past. In 1951 the American Association of Physical Anthropologists and some 20 other learned societies formally condemned a measure adopted by the board of directors of the University of California as "violating the rights of academic freedom and tenure." In 1955 the same association declined to participate in the meeting of the AAAS in Atlanta, Georgia, because of racial discrimination in that state.
6. P. B. Medawar, *The Future of Man: The Reith Lectures, 1959* (Methuen, London, 1960), p. 54.
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8. E. Caspari, "Genetic basis of behavior," in *Behavior and Evolution*, A. Roe and G. G. Simpson, Eds. (Yale Univ. Press, New Haven, Conn., 1958), pp. 103–127.
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The Scientist and World Affairs

The inference to be drawn from Florence Moog's comment on the present state of affairs [*Science* **134**, 797 (1961)] is that the world is no longer our business, as scientists, and we had best retreat to our cracked and yellowed ivory towers and leave the affairs of the world to those who are presumed to know more about them. I agree that we are perilously close now to "the flaming ramparts of the world, when the thundering regions of the sky will fall

upon us and the earth will slip beneath our feet," but this is no reason for starting a stampede to a nunnery—or monastery. Of course science, by itself, cannot claim to answer "the important questions," any more than art, religion, economics, or politics in themselves can solve the problems of the world. These terms are simply abstractions of what men do as their way of life.

Some years ago Moog took me to task because I obviously thought this was not the best of all possible worlds [*Am. Scientist* **35**, 541 (1947)] and defended "progress" (which, as is well known, I have always considered a snare and a delusion) with a ringing quotation from *Pippa Passes*. Now she seems willing to agree that it is indeed a bleak world, that perhaps, as I previously intimated, we are throwing a relentlessly dynamic ecosystem out of balance with our tamperings [*Am. Scientist* **35**, 395 (1947); **36**, 314, (1948)]. While I take small consolation in having been one of the first to take a dim view of the atomic age [*Science* **103**, 236 (1946)] I still think we should try to cultivate our gardens rather than retreat to them and watch the weeds take over. As scientists we are at least members of an international community and contributors to the only open synthesis mankind has so far devised. Theorems or gadgets will not save the world or answer its questions; if it is to be saved at all it will be through human consent and understanding, and we have a small duty, as scientists, toward that end. The world may be too much with us, late and soon, but even when cast overboard in mid-ocean a man will try to swim. Moog seems to be advising us to fold our arms and sink mutely to the bottom. Obviously, Browning is no longer her favorite poet. She might try Lucretius: "No night ever followed day, or dawn followed night, but has heard mingled with [children's] sickly wailings the lamentations that attend upon death and the black funeral."

JOEL W. HEDGPETH
University of the Pacific,
Pacific Marine Station,
Dillon Beach, California

Aside from the assertion that Browning was ever my favorite poet, I am not in disagreement with most of what Hedgpeth has to say. His attitude toward the social responsibilities of scientists is not different from mine. My letter did not say, nor did I mean it to imply, that I think that scientists should turn their backs on the "affairs of the

world"; and I know from numerous kind comments I have received that other people did not read the letter that way.

Were I inclined to the ivory tower, surely I would not be a member in good standing of the American Civil Liberties Union, Americans for Democratic Action, the Congress of Racial Equality, the National Association for the Advancement of Colored People, and several similar organizations; I would not have helped to circulate the Pauling petition; nor would I have contributed much time, over the past 2 years, to the editing of the bulletin published by the Greater St. Louis Citizens' Committee for Nuclear Information. I think that Hedgpeth has developed a curious allergy that makes him break out into a rash of disagreement at the very sight of my name.

FLORENCE MOOG
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Chemical Analysis by Mass Spectroscopy

In his very interesting article on the use of x-ray fluorescence analysis as a tool for chemical analysis in biology (*1*), Theodore Hall has included a table entitled "Capabilities of some methods for assay of chemical elements." Among these methods he lists mass spectroscopy. His Table 1 indicates that the minimum concentration detectable by this technique, "in the specimen fed to the device," is about 10^{-6} parts per million.

This statement, he says in his reference *31*, rests upon data given in a 1955 paper by M. G. Inghram (*2*). It is, however, a slight misinterpretation of Inghram's statement. It is the purpose of the present letter to make more clear the actual range of usefulness of mass spectroscopy. In brief, a sensitivity of one part in 10^{12} may well be attained in the near future, but it as yet has not even been approached by any commercial instrument. Nevertheless, present-day analytical mass spectrometers and spectrographs are indeed highly sensitive instruments; in fact, spark-source-equipped mass spectrographs are now pushing down into the one-part-per-billion (10^{-9}) region, in favorable cases. Some of the best electron-bombardment-source gas analysis instruments also approach this sensitivity. With a "tandem" instrument

(in which the ion beam passing through the image slit of the first spectrometer is again resolved into components of different mass-to-charge ratio in a second analyzer) the Knolls Atomic Power Laboratory research group has in fact demonstrated (*3*) an abundance sensitivity, in the low mass region, approaching 10^{11}. So it seems that the possibility of determining impurities present at the 10^{-12} level does in fact exist.

However, the sensitivity cited by Hall has been achieved only in certain isotope dilution experiments. And such experiments in general require some chemical processing of samples, usually with rather extensive preconcentration. In fact, the usable sensitivity of this technique is in general limited by contamination and instrumental background problems, the highest sensitivities being reported for nuclides that do not occur at all naturally, or that are of very small natural abundance, especially in laboratory and reagent environments.

Hall's Table 1 appears to state that mass spectroscopy *in toto* is appropriate to the analysis of only 68 elements. This statement likewise applies just to the isotope dilution technique, where the limiting factor is, of course, whether there exists an isotope of the element to be determined which is suitable for use as the internal standard (that is, which is in reasonably good supply and which is either stable or, if radioactive, of long enough half-life to permit one to perform the desired experiment). No such limitation applies when the spark, the crucible, or certain other ion sources are used. The N range of mass spectroscopy thus includes all the elements which have isotopes of long enough half-life to survive during the very short transit from ion source to detector. There is no Z limit for the instrument. And mass spectroscopy of course yields data on isotopic composition as well as on elemental abundance.

The minimum weight of element detectable by the technique may, in favorable cases, be well below the 10^{-12} grams listed by Hall; and, while the technique must in general be classed as destructive, amounts consumed in several ionization techniques are so small that it can, in these cases, be considered at least as nondestructive as, say, the electron-probe microanalyzer mentioned by Hall. Our organizations are in fact working jointly on the development of a mass spectroscopic analog of this device, which, we believe, will be able to exceed the sensitivity limit of the secondary x-ray microprobe by several orders of magnitude, while not being subject to its "blind spot" limitations.

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Department of Geophysics, Pennsylvania State University, University Park

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Nuclide Analysis Associates, State College, Pennsylvania

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The foregoing comment by Herzog and Marshall is a much fuller and better exposition of the capabilities of mass spectroscopy than appears in my article, partly because it is impossible to delineate a method's scope with one line in a table plus a brief footnote, and partly because I am not a mass spec-

troscopist. I must accept their main point: at present one cannot analyze directly down to a concentration of 10^{-12} for a wide range of elements in biological materials.

In extenuation, it should be noted not only that Table 1 in my article was characterized in the text as quite approximate but that the entry for mass spectroscopy posed a special problem. For most of the methods listed in Table 1 I drew on performance figures achieved during extensive biological research. For mass spectroscopy there is no comparable literature, and the technique has not had the benefit of comparable intensive biological trial. The inherent sensitivity of the method would be obscured by listing limits representing the present degree of mastery of contamination. I tried, rather, to tabulate the outstanding inherent sensitivity, leaving the implication that the method should play a larger role in biological trace work. This implication seems to be confirmed by the remarks of Herzog and Marshall.

May I add a few brief comments. I did not refer to commercial instruments, and I did not mean to imply that the isotope dilution method of mass spectroscopy (with its approximately 68 suitable isotopes) was the only method suitable for trace work.

I cannot quite agree with Herzog and Marshall's comment on nondestructive analysis. One hopes to analyze identified microentities; hence, much of the advantage of nondestructiveness is generally lost if the unconsumed and the analyzed regions are not identical. The degree of destructiveness of the electron microprobe is not yet established, but even if it destroys a circular area 1 micron in diameter, with the surroundings remaining recognizable, I believe conventional mass spectroscopy cannot hope to match it in nondestructiveness. Of course, mass spectroscopy with a microfocused ion beam could conceivably be similarly nondestructive.

With respect to "blind spots" I should mention that several laboratories are now seeking intensively to extend x-ray spectroscopy down to atomic number 6.

In summary, I think that the exposition by Herzog and Marshall should be stimulating to trace-element biologists, and I hope we may have even more detailed evaluations of the capabilities of the mass spectrometric method.

At this point I would like to make amends for an unrelated omission in my recent article: With respect to zinc concentrations in malignant prostatic tissue, although I did not seek to give a comprehensive bibliography, I should have listed a relatively early work, "The occurrence of zinc in the human prostate gland," by C. A. Mawson and M. I. Fischer [*Can. J. Med. Sci.* **30**, 336 (1952)].

THEODORE HALL
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Sparing of Folinic Acid by Thymidine

In the recent report "Sparing of folinic acid by thymidine," by Grossowicz and Mandelbaum (*1*), it is quite clear that several important literature references are lacking.

The synergistic action of folinic acid and thymidine in stimulating the growth of *Pediococcus cerevisiae (Leuconostoc citrovorum)* ATCC 8081 was first noted by Bardos *et al.* (*2*). Furthermore, the finding that thymidine increased the

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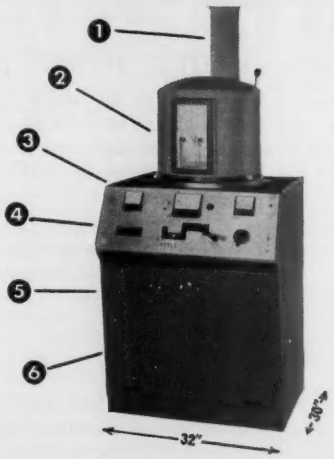

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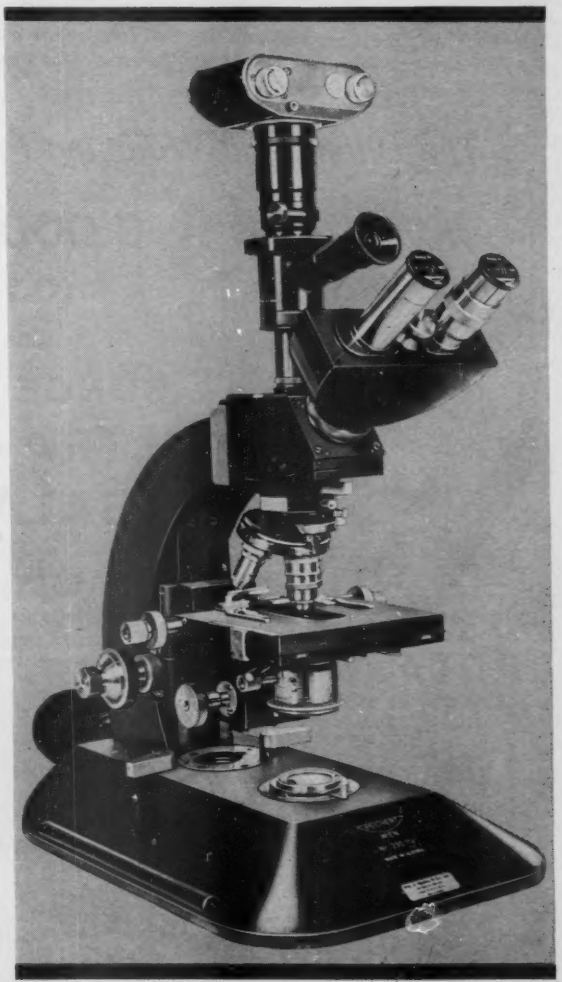

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growth of *P. cerevisiae* in the presence of high concentrations of pteroylglutamic acid (folic acid) was originally made by Broquist *et al.* (*3*).

The sparing of folinic acid by thymidine has interested several authors. Broquist *et al.* published a figure on this phenomenon (*4*, p. 402, Fig. 2), although a concentrate from liver was used as a source of folinic acid. A most thorough investigation on this subject has been published by Ellison and Hutchinson (*5*, p. 467); in their report both "the sparing effect of thymidine on the response of *P. cerevisiae* to citrovorum factor" (*5*, p. 473, Fig. 4) and "the sparing effect of citrovorum factor on the response of *P. cerevisiae* to thymidine" (*5*, p. 473, Fig. 5) are given. Review articles have also mentioned that thymidine will reduce the requirement of *P. cerevisiae* for folinic acid, a finding which is of importance in the assay for folinic acid of natural materials containing thymidine (*6*, *7*).

In connection with studies of the synergistic growth effects on *P. cerevisiae* of folinic acid plus thymidine and of folic acid plus thymidine, the effect of folinic acid plus folic acid is also of interest. This has been investigated by Hendlin *et al.* (*8*), who found that media supplemented with subminimal levels of folic acid or N^{10}-formyl folic acid (rhizopteringlutamate) gave a threefold to fourfold increase in the response of *P. cerevisiae* to folinic acid.

Another interesting finding concerning *P. cerevisiae* is the growth-inhibiting effect of deoxyuridine noted by Bolinder and Kurz (*9*). The growth-promoting effect of suboptimal amounts of folinic acid (leucovorin) was inhibited noncompetitively by deoxyuridine. However, the growth-promoting effect of suboptimal amounts of thymidine (0.1 to 3 μg per 10-ml tube) was competitively inhibited by deoxyuridine, and an inhibition index of about 30 was obtained after 48 hours of incubation at 37°C. No inhibition occurred when leucovorin or thymidine were present in amounts sufficient to promote optimal growth of *P. cerevisiae*.

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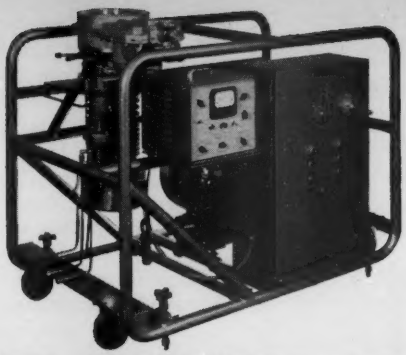
I am embarrassed about not having seen the paper of Broquist *et al.* (*1*) prior to submitting our report for publication. Bolinder is certainly justified in bringing the information to light; however, I consider that he makes too much of an issue of it. I believe I have good knowledge of the literature, although it is quite difficult nowadays to keep up with all the published works in a given field. With reference to this subject, I have corresponded with some of the workers in the field, asking for their interpretations of the differences in the results obtained. Moreover, I showed our results to E. L. R. Stokstad, a coauthor of Broquist's (*1*), and he did not mention having obtained results similar to ours some 10 years ago.

My failure to see the article of Broquist (Bolinder's references *2*, *5*, and



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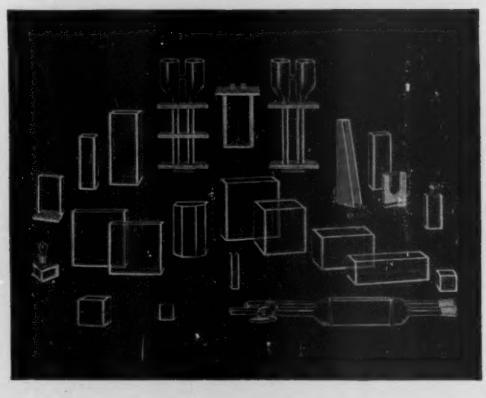

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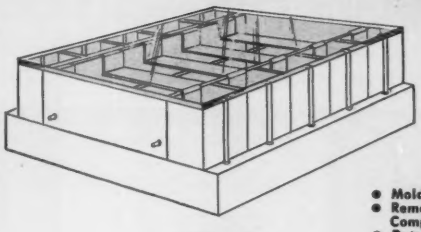

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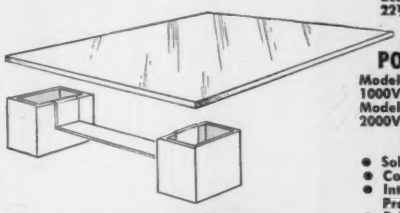

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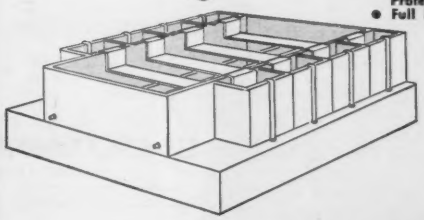

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6 are much less relevant) is due to the fact that it dealt with different aspects of folic acid (the title is "Some biological and chemical properties of the citrovorum factor") and therefore slipped my attention. I learned about the synergistic effect of folinic acid and thymidine from the recent review of Girdwood (*2*). This was, however, after our article had already been printed.

In retrospect I feel that our "rediscovery" of the sparing of folinic acid by thymidine served a good purpose, as many workers, like ourselves, did not know about the previous publication. I base this statement on the fact that there is quite a demand for reprints of our article. Thus, in spite of oversight on my part, our paper served to disseminate useful scientific information.

I feel that if *Science* as well as other journals would put more emphasis on the importance of identifying articles by proper headings, a slip of this sort would become a rarity.

With regard to the information presented in our report I would like to emphasize that in addition to the phenomenon of synergism, our findings demonstrate for the first time the quantitative aspects of the effect with pure compounds (the chemical authenticity of "folinic acid" was not established in the articles of Broquist *et al.* and the others). Moreover, in our system thymidine alone is ineffective, while it produced growth in their experiments (Bolinder's references *2* and *3*).

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Migrant Asian Students

The influx in recent years of Asian students in our universities has often presented problems of adjustment, owing perhaps as much to inadequately informed advisers as to the radically new cultural and academic patterns facing many of these students. Counselors of graduate students and, more especially, faculty members involved in educational exchange programs may on rare occasions have failed to notice

the very wide discrepancies in academic preparation or in scholastic and social adaptabilities among visiting students, and awkward situations may have arisen from this circumstance.

Because the great majority of these students eventually return home as teachers and professionals to environments where readaptation is frequently equally difficult, it seems to me important that our university faculties should consider certain sociological aspects of these student migrations. Their complex repercussions may not be more than superficially apparent to many scientists in the United States. Yet these are problems which in the long run are bound to produce far-reaching effects in countries in the throes of rapid social change, and in ways now difficult to foresee.

The problems facing the universities and university students in one such underdeveloped country of crucial importance, India, have been succinctly and, in my opinion, ably and sympathetically discussed in a recent issue of a periodical which my colleagues in the sciences are apt to overlook. I should like to urge those interested in the potentially wider results of their teaching and counseling efforts to read "Indian students," by Edward Shils, in the British journal *Encounter* [**17**, No. 3, 12 (1961)].

BALAJI MUNDKUR
Department of Zoology,
University of Connecticut, Storrs

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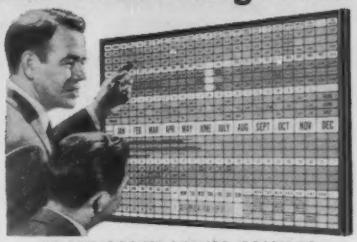

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(B.S.-M.S. Degrees)

Limited openings in Science Information Department for persons with B.S. or M.S. in the biological sciences. To evaluate laboratory, clinical studies, and other scientific data in connection with new drug research. Pleasant, stimulating work atmosphere. Liberal benefits—progressive policies. Send complete personal history to:

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(a) **Director of Virus Research**, eastern pharmaceutical house; $10,000–$15,000. (b) **Physical Chemist**, industrial research, $9000–$10,000; Midwest. (c) **College of Pharmacy Faculty Appointments**, eastern university. (d) **Biochemist**, protein research; eastern medical school, $10,000–$13,000. e) **Pharmacologist**, cardiovascular background; southern pharmaceutical firm. (f) **Physiology Faculty**, eastern medical school, $6000–$10,000. (g) Chemist, orthopedic research; Midwest; $8000 up. (h) **Biochemistry-Microbiology Appointment**, southern university. (i) **Clinical Laboratory Director**, East, $10,000–$12,000. (j) **Physics Professor**, western liberal arts college. (k) **Chemical Engineers**, adhesive textile or plastic experience; Midwest; $8000–$11,000. Many other opportunities available. Please write Science Division, **THE MEDICAL BUREAU, INC.**, Burneice Larson, Chairman, 900 North Michigan Avenue, Chicago 11, Illinois. X

COURSES

SUMMER COURSE: A 3-week intensive course will be held at the Loomis Laboratory, Calhoun Drive, Greenwich, Conn., 2–20 July inclusive, 1962, for a small number of senior biological workers on the biochemistry of cellular differentiation. The theory and practice of pCO_2, pH, pO_2 and pNH_3 control of differentiating hydra cultures will be considered as well as other differentiating systems. Interested workers should consult the laboratory for further details. X

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CAREERS IN BIOCHEMICAL PHARMACOLOGY

Predoctoral and postdoctoral research fellowships are available for training and research directed towards an understanding of the molecular basis of drug action, with particular emphasis on chemotherapy, development of resistance, amino acid and vitamin metabolism, drug adaptation, metabolic inhibitors, and mechanism of drug/enzyme interactions. Interested applicants should contact the Chairman, Department of Pharmacology, **Tufts University School of Medicine**, Boston 11, Mass. 1/5, 26; 2/16; 3/16

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METABOLIC RESEARCH POSTS

Emphasis on endocrinological research has stimulated the creation of two new positions in our Metabolic Department. Each offers an opportunity to the creative, energetic scientist to participate fully in laboratory programs aimed at the discovery and development of significant new pharmaceutical products.

ENDOCRINOLOGY SECTION HEAD

- Should possess Ph.D. or M.D. degree with strong background in basic medical sciences plus demonstrated interest and experience in the study of endocrine function and dysfunction.
- To direct basic and applied research programs and to supervise activities of several Ph.D.'s and their groups.

SENIOR LABORATORY SCIENTIST

- Should possess Ph.D. degree with broad training in physiology or basic medical sciences with special interest in relationship of biochemistry to bodily function.
- To conduct laboratory investigations of new chemical leads thought to be useful in correcting metabolic disorders.

Please send resume, including salary requirements, to —

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A MESSAGE DIRECTED TO ENGINEERS AND SCIENTISTS WHO HAVE RECEIVED THEIR DOCTORAL DEGREES AND ARE RECOGNIZED AUTHORITIES IN THEIR FIELDS

KEARFOTT ANNOUNCES THE ESTABLISHMENT OF A NEW RESEARCH CENTER FOR THE AEROSPACE SCIENCES

under the direction of Dr. Robert C. Langford

To meet accelerating national goals in space, upper atmosphere flight and undersea defense, radical advances in many technologies are essential. Kearfott, long a leader* in the development of systems and components for control, navigation and guidance, is preparing to enhance its endeavor in these and allied areas, through a multidisciplinary program of Applied Research. To this end, the new Research Center has been established. It will complement but not duplicate discrete R&D activities of the 26 Kearfott laboratories now functioning within the company's 8 Engineering Divisions.

*20 Kearfott precision instrument devices played a part in recent successful space flights of America's astronauts.

Dr. R. C. Langford, Director of the new Kearfott Research Center, has joined Kearfott after 18 years as R&D Director in a major electronics corporation. He was graduated with a Doctorate as a Swan Research Fellow from the University of London. He is senior member of IRE, a founder member of the American Nuclear Society and a member of the American Rocket Society. An author of technical articles and lecturer, he has also been a member of a U.S. Government committee analyzing Russian accomplishments in the electronic and solid state fields.

Dr. Langford Details Kearfott Philosophy of New Center

"This will be a scientific community entirely concerned with scientific and technical investigations; totally divorced from administrative or development responsibilities.

"Principal Staff Scientists will report to the Director—without any intervening 'level-of-command' to obscure a research man's ideas."

THE CENTER'S METHOD OF PROBLEM-SEEKING "Study areas will be related as closely as possible to urgent government needs. Senior members of the staff will seek, in conjunction with government scientists and other personnel, to determine the most difficult problems requiring solution (particularly but not exclusively, in control, navigation and guidance areas). It will then be up to the Center scientists to formulate appropriate investigations."

RESEARCH RESPONSIBILITY "The individual will guide his own research, calling upon Center resources for any technical assistance he requires. (Successful concepts will be carried to the prototype stage by Kearfott's engineering organization, without close supervision by the scientist, who may turn to other problems)."

CONSULTANTS IN LEADING INSTITUTIONS "Arrangements have been made for consultation with outstanding authorities at universities and foundations in this country and abroad. A stimulating cross-fertilization of ideas is projected, both with colleagues here and outside the Center."

SERVE ON DOD COMMITTEES "In the national interest, Center scientists will themselves feel free to act as consultants to agencies of the government and serve as desired on committees of the Department of Defense or other national agencies as independent authorities."

TECHNICAL INFORMATION SERVICES "A comprehensive collection of classified and unclassified technical source material will be available as well as the services of professional librarians to make library searches.

"Other facilities include excellent laboratory equipment, access to computer and data processing services; private quarters will be provided as soon as the RESEARCH CENTER building is completed in the summer of '62."

MEN WITH SCIENTIFIC VISION... and a touch of the missionary spirit that plays a significant part in building a research capability of this order, are invited to inquire about key appointments now open in areas indicated at the right. (A doctoral degree, and at least eight years research experience, is mandatory).

Oceanography — to investigate natural phenomena, in order to arrive at a more perfect understanding of the effect of earth sciences on systems required by government. (A vessel will be provided)

Radiation Sciences — to increase understanding of plasmas, wave propagation; to fully explore energy conversion and infrared technologies.

Astrospace Environments — to study natural phenomena in order to provide a more perfect understanding of environmental boundaries of space systems.

Hydraulics & Pneumatics — to provide a fuller understanding of fluid technology in dynamic systems.

Guidance & Navigation — Terrestrial and Celestial — to develop a broader comprehension of the needs of future systems.

Physics — Specialist in Modern Materials research pertaining to solid state, fluid, magnetic and dielectric materials.

Chemistry — to develop and extend range and application of organic and inorganic materials. Activity will be in both materials and processes.

Metallurgy — to serve as authority on metallurgical properties of Modern Materials — function-wear, defect propagation and anelasticity.

Please write Dr. Langford at some length about your interests and past work. Copies of papers written or presented will be appreciated —and returned, if desired.

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